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INTELLECTUAL OBSERVER

OF

SCIENCE, LITERATURE AND ART.

VOLUME IV.

ILLUSTRATED WITH PLATES IN COLOURS AND TINTS AND NUMEROUS ENGRAVINGS ON WOOD

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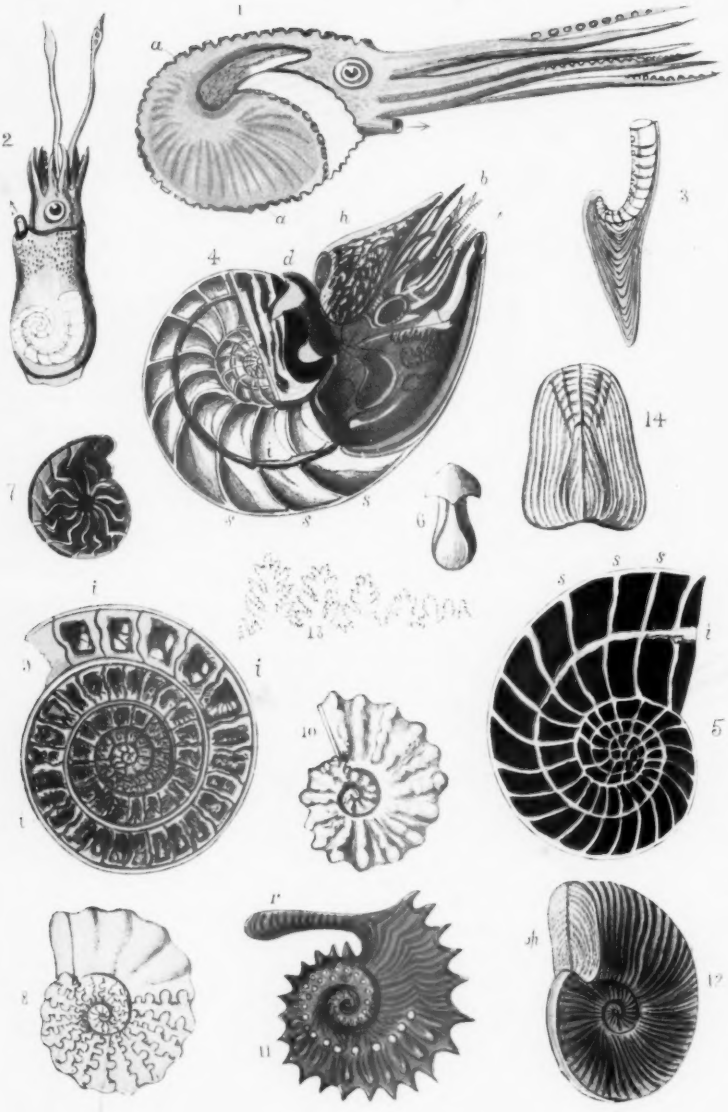


RECENT AND FOSSIL CEPHALOPODA.

THE STUDENT,

AND

INTELLECTUAL OBSERVER.

THE PEARLY NAUTILUS, CUTTLE-FISH, AND THEIR ALLIES.

BY HENRY WOODWARD, F.G.S., F.Z.S., ETC.,

Of the British Museum.

PART I., WITH PLATES I. AND II.

THE group of animals to which the Nautilus and Cuttle-fish belong are called *Cephalopoda*,* on account of the long prehensile processes, or feet, which are attached to the head around the mouth: this character, possessed in common by the whole class, was happily selected by Linnæus for its designation.

From the nature of their organs, and from some of them possessing external shells, they have been placed in the Sub-kingdom MOLLUSCA, of which they are certainly the highest class.

We are all familiar with the forms of snails, whelks, mussels, oysters, cockles, etc., these represent other classes of the same Molluscan Sub-kingdom.†

In external form, there certainly does not appear, at first sight, to be much relationship between Cephalopods and Snails; but the Pearly Nautilus and the snail both secrete a shell, in which their soft

* From *kephale*, head; and *poda*, feet.

† The writer begs to recall attention to three previous articles, "On the Form, Growth, and Construction of Shells;" and "On the Economic Uses of Shells, and their Inhabitants," which appeared in the "Intellectual Observer," Vol. x., 1866, pp. 241—253; Vol. xi., 1867, pp. 18—30, and pp. 161—172.

bodies are protected, which is harder than bone, and equally unlike the skeleton of fishes and the hard covering of the crab and lobster.

The garden slug has no shell; but its organs are like those of a snail, fashioned on the same type. The Poulpe, or *Octopus* has no shell, yet it is exactly like the shell-bearing Argonaut.

Between these again we can find analogies. For example—some marine snails have a thin internal shell, as *Aplysia* and *Bullæa;* and also some land-slugs, as *Parmacella, Limax,* etc.

These are comparable to the Squids and Calamaries among the Cephalopods, which also have a thin internal shell. (Plates III. and IV.)

But in the highly-developed condition of all their organs, they are as much elevated above the rest of the Mollusca, as the sharks are above the rest of the fishes. And like the sharks, the *Cephalopoda* are among the earliest representatives of their class, and can date back their history almost to the most ancient rocks in which Molluscan life has been detected.

Remains of *Orthoceras,* an extinct representative of the class, have been met with in lower Silurian strata, and species of *Cephalopoda* occur, recent and fossil, in every part of the world, in rocks of all ages, and living both in temperate and tropical seas.

The *Cephalopoda* belong to that division of the Molluscan Sub-kingdom, known as the Encephalous Mollusca (*i.e.* having a head), and include first the *Cephalopoda—Nautilus,* Ammonite, Cuttle-fish, etc.; secondly, the *Gasteropoda* or snails, slugs, whelks, *Trochus, Littorina,* etc. (See accompanying table.)

TABLE SHOWING THE CLASSIFICATION OF THE SUB-KINGDOM MOLLUSCA.

[A.] ENCEPHALA—*with a distinct head*—(Univalves).

I. *Cephalopoda.*—1. *Dibranchiata—Sepia, Loligo, Octopus.*
2. *Tetrabranchiata — Orthoceras, Ammonites, Nautilus,* etc.

II. *Gasteropoda.*—1. *Prosobranchiata—Strombus, Murex, Buccinum, Littorina, Paludina.*
2. *Pulmonifera*—Land-snails, *Helix, Achatina,* Garden-slugs.
3. *Opisthobranchiata* — Sea-slugs, *Bullæa, Aplysia, Doris.*
4. *Nucleobranchiata—Firola, Carinaria, Bellerophon* (OCEANIC).

III. *Pteropoda.—Aporobranchiata—Oceanic* (habits like larvæ) *Hyalæa, Creseis, Cleodora.*

[B.] ACEPHALA—*without a distinct head*—(Bivalves).

IV. *Palliobranchiata—Brachiopoda* (Lamp-shells), *Terebratula.*

V. *Lamellibranchiata.* Mussel, oyster, etc.

VI. *Heterobranchiata. Tunicata, Botryllus, Ascidium.*

If we examine the soft parts of any Cephalopod we shall find the animal to possess a head, to which is attached the principal locomotive organs, which are composed of a circlet of muscular arms, or tentacles, in addition to which many have fins. These arms are also the grand organs of prehension by which they seize and hold fast their prey, and convey it to the mouth, which is situated in their centre. (Plate III., Fig. 4.)

The mouth is armed with powerful jaws, resembling, both in form, texture, and position, the mandibles of a bird. (Plate III., Fig. 3.)

The tongue is large and fleshy, and in part seems to be endowed with touch and taste, and in part is armed—as in the *Gasteropoda*—with recurved spines or teeth. (Plate III., Fig. 1.)

But the eyes are perhaps the most striking organs in these creatures, being both large and brilliant, and well express the keen activity and alertness for which the majority of this wonderful group are conspicuous. (Plate I., Figs. 1 and 2, Plate III., Figs. 5—9).

The *organs of respiration* consist of two or four plume-like gills, placed symmetrically on the sides of the body, and inclosed in a branchial sac or chamber, having its opening directed forwards on the under side of the head.

It is by the forcible expulsion of the water from this respiratory chamber, that they are enabled to propel themselves backwards through the sea when swimming.

The whole of this curious group is divided by Prof. Owen into two great parts, founded on the gills.

I. The *Dibranchiata* (*having two gills*)—including all the cuttle-fishes; the Argonaut, Spirula, etc., in which (with one exception, the *Argonaut*) *the shell is internal.*

II. The *Tetrabranchiata* (*having four gills* and an *external shell*) —represented by a single living genus, the Pearly Nautilus; but in Silurian times by 34 genera, and above 1400 species.

As these come in *first in geological time,* and as I propose in this paper to speak of both the living and fossil forms, I will first refer to the ancestors of the Pearly Nautilus. (Plate I., Fig. 4.)

The shell in all the animals of this division is, geometrically speaking, an extremely elongated cone, either straight or variously folded and coiled.

The Palæozoic species (of which *Orthoceras* (Plate II., Fig. 13) is a type) had *simple sutures—not complex*, as we shall presently see is the case with the *Secondary* forms—but the shell varies, as in the later type, between

Straight in *Orthoceras*, Plate II., Fig. 13.
Bent on itself in *Ascoceras*, Plate II., Fig. 7.
Curved in *Cyrtoceras*, Plate II., Fig. 10.
Spiral in *Trochoceras*, Plate II., Fig. 15.
Discoidal in *Gyroceras*, Plate II., Fig. 14.
Discoidal and produced in *Lituites*, Plate II., Fig. 8.
And involute in *Nautilus*, Plate I., Figs. 4 and 5.

The *Shell, internally*, is divided into cells or chambers, by a series of septa or partitions, connected by a tube or *siphuncle*. (Plates I. and II.) The last chamber is occupied by the animal. The rest are empty, during life; but in the fossil state are found filled with spar (See Plate I., Figs. 5 and 9), or, when partly broken, with mud.

The siphuncle in the recent *Nautilus* is a membranous tube, with a very thin pearly covering. In the fossil genera it is composed of a succession of funnel-shaped or bead-like tubes; whilst in some of the oldest genera (e.g. *Actinoceras*, *Gyroceras*, and *Phragmoceras*) the siphuncle is large and contains in its centre a smaller tube with radiating plates between, like the lamellæ of a coral. (See Plate II.)

In many instances the siphuncle is preserved and the shell destroyed, giving the appearance of a string of beads, or of a series of *vertebræ* of some higher animal. Such is frequently the case in *Actinoceras*, *Huronia*, etc. (Plate II., Figs. 16 and 17.)

Siphuncles of *Huronia* six feet in length and one and a half inches in diameter, may be seen standing out in bold relief from the cliffs of Silurian rock on Drummond Island, Lake Huron, North America, unaccompanied by a vestige of the shell, save in one or two instances only, when the chambers could be faintly traced out. Dr. J. J. Bigsby, F.G.S. (formerly British Secretary of the Canadian Boundary Commission), has placed a series of these remarkable fossils in the British Museum.

In *Orthoceras* there appears to be evidence of a continued connection, through these large and complex siphonal tubes, with the whole series of body-chambers, but if this is the case in the other Silurian *Cephalopoda* it cannot be in the *Nautili*, as I shall have occasion to show presently.

The position of the siphuncle is very variable. In the *Ammoni-*

tidæ it is *external*, or close to the outer margin of the shell (Plate I., Fig. 9, *i.*). In the *Nautilidæ* it is usually central or *internal* (Plate I., Fig. 5). This is the case also in *Orthoceras* (Plate II., Fig. 13), which may be considered as a *straight Nautilus*.

The body-chamber is very capacious; in the recent *Nautilus*, its cavity is twice as large as the whole series of air-cells (Plate I., Fig. 4); in the *Goniatite* it occupies a whole whorl, and has a considerable lateral extension (each portion becoming *thicker*). In *Ammonites communis* it occupies more than a whorl of the shell.

In some of the Silurian forms (such as *Gomphoceras* and *Phragmoceras*), the aperture (Plate II., Fig. 12) is so much contracted, that it is obvious the animal could not have withdrawn its head into its shell as does the living *Nautilus*.

The shell appears to have been less calcified in *Orthoceras* than in the recent *Nautilus*, and also to have been more closely connected with the nutritive system of the animal, but nevertheless it was so large in many of the species, and the colour-bands having been detected in one instance that there is reason to presume the shell was essentially external. But it may have been enveloped, like the straight shell of the *Belemnites*, in the mantle of the animal. (Plate III., Fig. 6.)

The largest British species of *Orthoceras* occur in the Carboniferous limestone, and there are examples in the National Museum more than a yard in length and thick in proportion.

The most wonderful and varied assemblage of Silurian forms of *Orthoceratidæ* have been met with by M. Barrande in Bohemia, and are described by him in three volumes, with several hundred magnificent plates. They comprise 15 genera and 826 species, or *more than half* the *Orthoceratidæ* known and described throughout the whole world.

From the absence *in the older rocks* of the shells of carnivorous *Gasteropoda* (sea-snails, like the genus *Strombus, Buccinum, Rostellaria*, etc.), and the presence in such numbers of the remains of *Orthoceratites;* it has been inferred, and I think with justness, that the office of these animals was performed in the ancient seas by this order of *Cephalopoda*, now so nearly extinct.

When it is borne in mind that fishes only make their appearance towards the close of the Silurian epoch—the duties to be performed by the palæozoic *Orthocerata* must have been very arduous indeed, both as scavengers, and also in devouring the surplus population of those early seas.

Ammonitidæ.—The great group of discoidal shells classed in

the family of *Ammonitidæ* commence with the genus *Goniatites* (Plate II., Fig. 9), in the Devonian rocks, and *Ceratites* (Plate I., Fig. 8) in the Muschelkalk or Trias.

In *Goniatites* the sutures of the shell are very simple, and resemble in this respect the *Aturia zic-zac* of the London clay (Plate I., Fig. 7). In *Ceratites* the lobes are serrated, and the intervening "*saddles*" or curves which are directed forwards towards the mouth of the shell are simple.

One of the sutures of *Ceratites* drawn in plan (both sides and back are seen); *d*, dorsal lobe; *u*, *u*, umbilicus.

The *Ammonites* (or *cornu-ammonis* of old writers) have their head-quarters in the Lias and Oolites. All the Jurassic forms have compact discoidal shells, with their whorls all in the same plane of growth and united together (Plate I., Fig. 9).

But so soon as we come to the Greensand, Gault, and Chalk, we meet with several species which *have the appearance of having become 'uncurled,'* and which have assumed the most remarkable and fantastic forms of growth. Thus we have for example:—

1.—Straight shells, as in *Baculites* (staff), Chalk formation (Plate II., Fig. 2).
2.—Shells folded in two, as in *Ptychoceras* (ram's horn), Neocomian formation (Plate II., Fig. 1).
3.—Hooked shells, as in *Hamites* (hook), Gault formation.
4.—Spiral shells, as in *Turrilites* (tower), Chalk-marl formation (Plate II., Fig, 3).
5.—Open spiral shells, as in *Helicoceras* (twist horn), Gault formation.
6.—Trumpet-shaped shells, as in *Toxoceras* (bow-horn), Neocomian formation (Plate II., Fig. 5).
7.—Discoidal when young and *uncurled* in *adult* shells, as in *Scaphites* (boat stone), Neocomian formation.
8.—Whorls detached, as in *Crioceras* (ram's horn), Neocomian formation (Plate II., Fig. 4).

It is interesting to observe that in the two *oldest forms of Ammonites, Goniatites and Ceratites,* we have represented two of the stages of growth of the young Ammonite of the Secondary

rocks; that is to say with exceedingly simple sutures and smooth whorls.

Ammonites have been met with almost in every country in the world; and more than five hundred species have been described.

They are found throughout Europe, at the Cape of Good Hope, in Kamtschatka, Thibet, and Southern India.

They are absent from the large area of the United States, but occur in the Cretaceous rocks of New Jersey, Missouri, and Texas; also in Chili and Bogota in South America.

The Ammonites are divided into a number of groups for the convenience of classification.

1.—The first is called the "Cassiani," and includes the many-lobed Triassic *Ceratites*. (Plate I., Fig. 8.)

2.—The "Arietes" group having the back keeled, with a furrow on each side, as in the great *Ammonites Bucklandi* and *Conybeari*, which sometimes attain a growth of two feet in diameter! These mark the Lias period.

3.—The "Arietes" pass by many intermediate forms into the "Falciferi," which are *keeled*, but without the furrow on each side of the back.

The *Ammonites serpentinus* (one of this group) from the Lias of Whitby has been rendered famous by the allusion made to it in Sir Walter Scott's poem of "Marmion," Canto II., Verse 13, where the Whitby nuns exulting told—

> And how of thousand snakes each one,
> Was changed into a coil of stone,
> When holy Hilda prayed.

Every visitor to Whitby is invited to buy a petrified snake, and to add to their natural (?) appearance, the mouth of the Ammonite is carved into a head, and eyes are often introduced made of coloured glass. So great is the demand for Whitby Ammonites to sell to visitors from Scarborough and elsewhere, that they are now regularly imported from Lyme-Regis in Dorsetshire, where the supply is greater than the demand.

4.—The "Cristati" group is keeled, but not furrowed, and when adult, it develops a beak or process from the keel. *Ammonites rostratus*, *A. cristatus*, and *A. varians* are good examples of this group; they all belong to the Cretaceous strata.

5.—The "Amalthei" have the keel sharp and serrated or crenated. *Ammonites cordatus* from the Coral Rag is a

good example of the group: it is abundantly represented in the Lias by *A. margaritatus*.

6.—The next division is that of the "Rhothomagensis," a group of thick Ammonites with a line of tubercles in place of the keel; of which *Ammonites Rhothomagensis*, from the Chalk-marl of Sussex, is a good example. (Plate I., Fig. 10.)

7.—The "Disci," Oolitic Ammonites with a sharp back, represented by *Ammonites discus* and *clypeiformis*, are like the upper side of a quoit in form.

8.—The "Dentati"* have channelled backs, and occur both in Cretaceous and Oolitic strata. They are remarkable for their elegance. The well-known beautiful Gault and Greensand *Ammonites dentatus* and *lautus* (found and sold at Folkestone and Dover); also the *A. Parkinsoni* and *anguliferus*, from the Inferior Oolite and Lias, belong to this group.

9.—The "Armati"—example *A. armatus*—belong to the Lias.

10.—The "Capricorni"—example *A. capricornis*—to the Inferior Oolite.

These two groups have their backs more or less squared, and their sides ornamented with spines.

11.—The "Ornati," a third group, with square backs and ornamented with two rows of tubercles or spines when young, of which *Ammonites Duncani*, *A. Goweri*, and *A. Jason* (Plate I., Fig. 11) are examples, become rounded and unarmed in their old age.

The round-backed Ammonites are most abundant in the Oolites, and are divided into

12.—"Heterophylli" (example, *A. heterophyllus*; Lias, Lyme).

13.—"Ligati" (example, *A. planulatus*; Chalk-marl, Sussex).

14.—"Annulati" (example, *A. annulatus*; Lias, Whitby).

15.—"Coronati" (example, *A. coronatus*; Kelloway rock, France).

16.—"Fimbriati" (example, *A. fimbriatus*; Lias, Lyme Regis).

The "Heterophylli" are remarkable for the foliations of their sutures which are extremely elegant and diverse.

The "Ligati" have nearly smooth whorls with constrictions at regular intervals. Some Cretaceous Ammonites placed in this division attain a vast size. Mr. Davidson has lately forwarded me

* Sometimes also termed "Colliciati" or "Tuberculati."

a drawing of one obtained by M. Geny of Nice which was not less than six feet in diameter when perfect.

The "Annulati" are remarkable for the number of the rings upon their whorls, giving them a very snake-like aspect.

The "Coronati" are ornamented with spines upon their lateral borders.

The "Fimbriati" have undulating and fimbriated lines of ornamentation at intervals on their whorls.

The entire group of Ammonites is remarkable for their highly ornamented sutures, and are, in this respect, distinguished from the *Orthoceras, Nautilus,* etc., which are very plain and simple in the form of their septal divisions. (See Plate I., Fig. 13.)

Many Ammonites exhibit what appears to be—judging from the rest of the Molluscan class—lines of periodic rests in growth, corresponding to the varices on the shells of *Ranella, Harpa, Scalaria,* etc., as if at certain periods they ceased to increase in size.

If we examine the animal in the recent *Nautilus* we shall see that it has a disk or hood (Plate I., Fig. 4, *h*), (corresponding in size with the aperture of its shell) formed by the union of the two dorsal arms, which are equivalent to the shell-secreting sails of the Argonaut. (Plate I., Fig. 1, *a*.)

In the extinct Ammonites, the aperture was guarded by a horny or shelly *operculum* (Plate I., Fig. 14), evidently formed in the same manner, by the soldering together of the two dorsal arms of the animal.

We have in the British Museum a very interesting little specimen of *Ammonites subradiatus,* Sby., from the Inferior Oolite of Dundry, near Bristol, in which the operculum still remains *in situ,* closing the aperture of the shell (See our Plate I., Fig. 12, *op.*). (Figured and described in "The Geologist" for 1860, p. 328.) They are frequently found in the body-chamber, and slightly shifted, as would naturally be the case in the decay of the soft parts of the animal.

They are mostly shelly and bilobed like the hood of the recent *Nautilus;* but an entire horny *operculum* was found by Miss Anning in the Lias of Lyme Regis. We have thus in the *Nautilus* and *Ammonite,* a perfect analogy to the Gasteropods, in which there are snails *without opercula,* snails with *horny opercula,* and snails with *shelly opercula.*

The *calcareous mandibles* of *Cephalopoda* occur in all strata in which the *Nautilus* is found fossil. Some of these no doubt belonged also to the *Ammonites.*

Like the opercula, the various fossil beaks have been named as

if they were distinct fossils. The mandibles of *Nautilus bidorsatus* from the Muschelkalk of Bavaria (Plate I., Fig. 6), have been named *Rhyncholites hirundo*, and *Conchorhynchus avirostris!*

The operculum of an Ammonite from the Oxford clay of Chippenham has been named *Trigonellites lamellosus;* others have been called *Aptychus* and *Münsteria* by Parkinson, Meyer, and Deslongchamps; they have been likewise referred to the *Cirripedia* and various other groups.

The *Nautilus* and *Ammonite* could no doubt swim like the rest of their family; but from the habits of the living *Nautilus pompilius*, we may conclude they were *bottom-feeders* in from 15 to 25 fathoms water.

The old Dutch naturalist, Rumphius, writing in 1705, and giving an account of the rarities of Amboyna, says:—

"When the *Nautilus* floats on the water, he puts out his head and all his tentacles and spreads them upon the water; but at the bottom he creeps in the reverse position with his boat above him, and with his head and tentacles on the ground, making a tolerably quick progress. He keeps himself chiefly upon the ground, creeping also sometimes into the nets of the fisherman; but after a storm as the weather becomes calm, they are seen in troops floating on the water, *being driven up by the agitation of the waves.* This sailing, however, is not of long continuance, for, having taken in all their tentacles, they upset their boat, and so return to the bottom."

Much time and ingenuity have been expended on the question of the purpose of the *air-chambers*, in reference to their *supposed* hydrostatic function whereby the *Nautilus* can rise at will to the surface, or sink, on the approach of storms, to the quiet recesses of the deep. Unfortunately, it seems the *Nautilus* only appears at the surface when driven there by storms, and its proper and natural habitat is the bed of the sea, where it creeps like a snail, or perhaps lies in wait for unwary crabs and shell-fish that may pass within reach.

The air-chambers seem to have a relative proportion to the weight and bulk of the animal, and serve to render it more nearly of the same specific gravity as the medium in which it lives.

An Ammonite with a shell a yard across would have an animal in its body-chamber big in proportion, and requiring such an amount of water to be displaced by his shell to move at his ease along the bottom of the sea.

So much is to be found in all books on the final uses and causes of certain structures that we have to exert all our resolution some-

times to look at a particular structure in a plant or animal and fairly consider how it comes to be so formed, and why it exists in a particular class and not in another.

Why should *Nautili* have chambered shells and garden snails not have them also? Surely there must be something in the economy of the animal to explain it.

At the meeting of the British Association, 1864, Mr. H. G. Seeley suggested that the periodic enlargement of the ovary and the regular extrusion of the eggs when ready to be hatched, causing the alternate enlargement and diminution of the bulk of the body of the animal, and the corresponding demand for space in the animal's body-chamber, would satisfactorily account for the formation of septa in the shell of the *Nautilus*. Now that we hear this very simple explanation, we see how exceedingly well it agrees with the phenomenon, and are ready to protest that we knew it long ago!

But we are told that the use of the air-chambers is to render the shell and contained animal of nearly the same specific gravity with the water, and the object of the numerous partitions is not so much to sustain the pressure of the water as to guard against the *collisions* to which the shell is exposed. Whereas it would appear that the septa in the *Nautilus* and *Ammonite* express (like the septa in the shell of the *Water Spondylus*) a filling-up of a vacancy caused by the *diminished size* of the animal and the necessity for the mantle-lining of the shell and the animal to hold together.

Again, how many chapters have been written on the *siphuncle?*

The purpose of the siphuncle (suggests Mr. S. V. Wood), is to maintain the *vitality* of the shell during the long life of the animal. This might be the case in the *Orthocerata* whose gigantic siphuncles have been already alluded to as most complex in their structure, and apparently opening out into the chambers. But the *Nautili* are a direct contradiction to the possibility of this; for how can a living connection be kept up with a *dead substance?*—and shell is dead when once it is formed, and can only be repaired and thickened by the mantle of the animal which at first secreted it.

When a Nautilus is cut open, we find a shelly tube traversing its interior, inside which is the siphuncle. This siphuncle always was possessed of most remarkable qualities. The late Dr. Buckland invented those wonderful pneumatic properties for it, by which its possessor could rise, by an effort of the will, from the depths of the ocean to the surface, and sink again by the same act of volition.

Subsequently we have been taught that the function of the

siphuncle is to keep alive the shell, an equally difficult task, as it would seem, surrounded as it is by a coat of pearl.

Von Buch suggested that its object was to hold the animal into its shell; but against this it was objected that the shell-muscles performed this task.

What, then, is the siphuncle?

In the mussel (*Modiola*) two additional muscles are developed, namely, the byssal muscles, which are equal to the great adductor muscle in size.

Should it be capable of proof that in the siphuncle of *Ammonites* and *Nautilus* we have a muscle analogous to the shell-muscle of the *Monomyaria*, then the two additional muscles may have been developed to subserve the special requirements of the animal, as in the byssal muscle of the *Modiola*.

In examining the shell of an aged oyster, from the Eocene beds of Bracklesham, I observed that the numerous septal layers of which the shell was composed had each the scar of the shell-muscle depressed, and fitting into the corresponding scar of the shelly layer beneath it, thus forming an incipient siphuncle. I could not fail being struck with the apparent analogy in structure here presented between the highest and lowest members of the same sub-kingdom.

It is not a little interesting to know that in the London clay, which forms such a large extent of the substratum of our great metropolis, lie buried vast numbers of the pearly shells of the *Nautilus*, which evidently once found here a congenial climate and a home; illustrating the change which Tennyson has so happily expressed:—

> "There, where the great street roars,
> Was once the stillness of the central sea."

I propose to devote the second part of this paper to the description and illustration of the other great division of the *Cephalopoda*, the *Dibranchiata*.

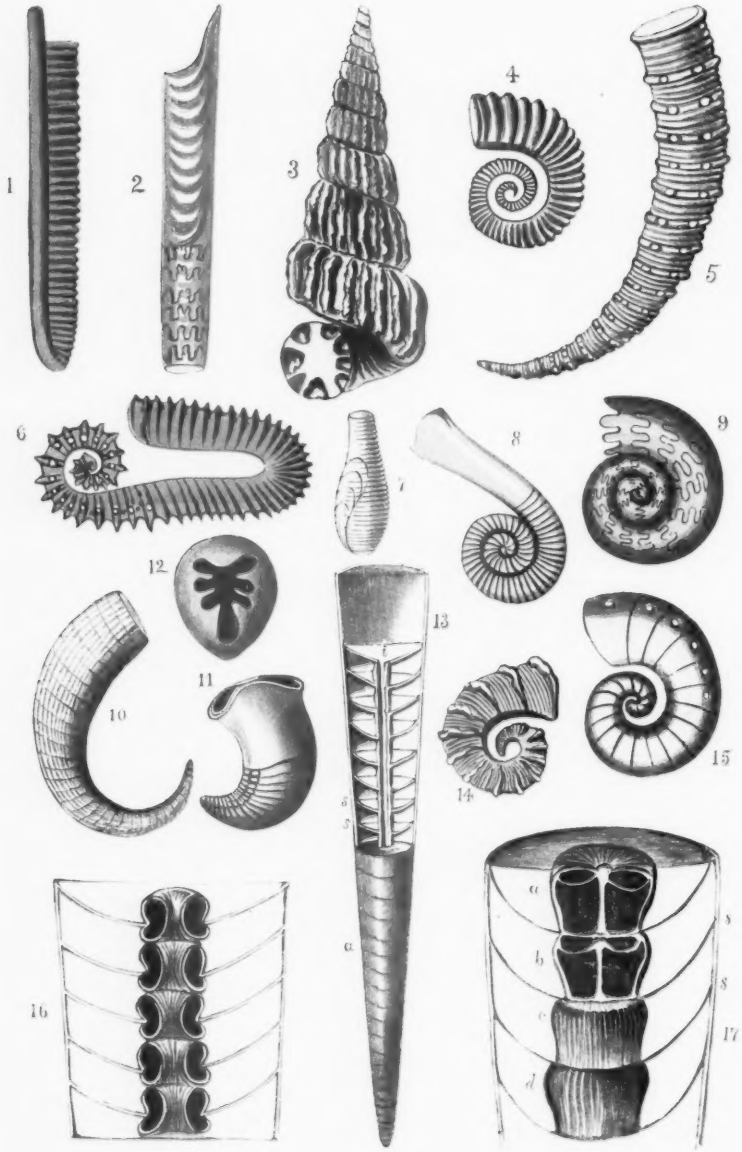
Explanation of Plate I.

Fig. 1. *Argonauta argo*, Linn. In the act of swimming (the arrow indicates the direction in which the water is ejected from the siphon).

Fig. 2. *Spirula lævis*, Gray. New Zealand, one-half natural size.

Fig. 3. *Spirulirostra Bellardii*, d'Orb. Miocene, Turin.

Fig. 4. *Nautilus pompilius* (part of the shell removed); (*b*, the arms; *h*, the hood; *m*, the shell-muscle; *d*, the dorsal



PALÆOZOIC AND SECONDARY CEPHALOPODA.

extension of the mantle; *i*, siphuncle; *s s s*, the septa; the arrow marks the outlet of the siphon).

Fig. 5. Section of *Nautilus striatus*, Sowerby. Lias, Lyme Regis. (*i*, siphuncle.)

Fig. 6. Upper mandible of *Nautilus bidorsatus*. Muschelkalk, Bavaria.

Fig. 7. *Aturia zic-zac*, Sowerby. London clay, Highgate.

Fig. 8. *Ceratites nodosus*, Brug. Muschelkalk, Wurtemburg.

Fig. 9. Section of *Ammonites Humphresianus*, Sby. Inferior Oolite, Sherborne (the interior is nearly filled with calcareous spar).

Fig. 10. *Ammonites Rhothomagensis*, Brong. Chalk-marl, Sussex.

Fig. 11. *Ammonites Jason*, Reinecke. Oxford clay, Chippenham. (*r*, rostrum.)

Fig. 12. *Ammonites subradiatus*, Sby. Inferior Oolite, Dundry (having its *operculum* (*op.*) *in situ*).

Fig. 13. Suture of *Ammonites Maximiliani*, Klip. Trias.

Fig. 14. Operculum of an Ammonite from the Inferior Oolite.

Explanation of Plate II.

Fig. 1. *Ptychoceras Emericianum*, d'Orb. Neocomian, South of France.

Fig. 2. *Baculites anceps*, Lamk. Chalk, France.

Fig. 3. *Turrilites costatus*, Lamk. Chalk-marl, Sussex.

Fig. 4. *Crioceras cristatum*, d'Orb. Gault, South of France.

Fig. 5. *Toxoceras annulare*, d'Orb. Neocomian, South of France.

Fig. 6. *Ancyloceras spinigerum*, Sby. Gault, Folkestone.

Fig. 7. *Ascoceras Bohemicum*, Barrande U. Silurian, Prague.

Fig. 8. *Lituites simplex*, Barr. U. Silurian, Bohemia.

Fig. 9. *Goniatites Henslowi*, Sby. Carboniferous Limestone, Isle of Man.

Fig. 10. *Cyrtoceras lamellosum*, d'Arch. and de V., Devonian, Paffrath, Rhenish Prussia.

Fig. 11. *Phragmoceras ventricosum*, Sby. Lr. Ludlow, Herefordshire.

Fig. 12. Mouth of *Phragmoceras* (showing contraction and plication of aperture of the last chamber).

Fig. 13. *Orthoceras giganteum*, Carboniferous Limestone, Yorkshire. (The upper part is shown in section, and exhibits (*i*) the siphuncle, (*s s*) the septa.)

Fig. 14. *Gyroceras Goldfussi*, Devonian, Eifel.

Fig. 15. *Trochoceras nodosum*, Barr. Silurian, Bohemia.

Fig. 16. Vertical section of *Ormoceras Bayfieldi*, Stokes, Drummond Island, Lake Huron, N. America (showing complex structure of siphuncle).

Fig. 17. *Huronia vertebralis*, Stokes; same locality as Fig. 16. (The joints (*a* and *b*) are cut open, and exhibit the inner tube of siphuncle; (*c* and *d*) are entire; (*s s*) the septa.)

The author desires to acknowledge that he is largely indebted to his brother, the late Dr. S. P. Woodward, F.G.S., for many notes and observations contained in this paper.

THE ASTEROIDS AND THE NEBULAR HYPOTHESIS.

BY RICHARD A. PROCTOR, B.A., F.R.A.S.,

Author of "Saturn and its System," etc.

At the last general meeting of the Royal Astronomical Society, it was mentioned that among other important accessions to astronomical knowledge during the past year, we have to congratulate ourselves on the discovery of no less than twelve asteroids—the largest number ever discovered in a single year. Whether this is a matter about which astronomers need be delighted may, perhaps, be questioned. When we remember the enormous amount of labour now involved in the discovery of a single asteroid, and that, unless all former experience is to be negatived, we may look for the time to come when sidereal photography will render the detection of asteroids an all but mechanical process, we may well be disposed to ask whether it is not rather a misfortune that some of our ablest and most thoughtful observers should be devoting so large a portion of their time to the search for these tiny worlds.

But whatever opinion we may form on this subject there can be no doubt that now so many asteroids have been discovered, the time has come when an attempt should be made to sort and arrange our somewhat dear-bought acquisitions in this line; and to educe from them, if possible, lessons of some interest.

I think, therefore, that Professor Kirkwood, of Indiana University, deserves the thanks of astronomers, for the able series of researches by which he has brought the asteroids into due correlation with the other members of the solar system, and has derived from the relations they present a powerful argument for the nebular hypothesis of Laplace—or rather, for those modified views of Laplace's hypothesis which have been suggested by the progress

of modern science. His conclusions are so interesting that I need make no apology for attempting to present an analysis of them, in which I have endeavoured to put the elaborate researches of the professor into a form better calculated perhaps to interest the general reader.

To begin with, it may be well to exhibit the real complexity of the problem, of which Professor Kirkwood has endeavoured to obtain a solution. This is the more necessary because whenever the asteroidal system is illustrated in works on popular astronomy, an amount of regularity is introduced into their orbital arrangements which is very far from corresponding to the complexity actually existing.

It will be well for the reader to construct a diagram of the orbits of some of the asteroids (on a scale larger than could be conveniently adopted in these pages). He should attend to the following considerations :—

While the asteroids exhibit a general obedience to the law according to which the members of the solar system travel near the plane of the ecliptic, there are individual cases of exception. Some of the asteroidal orbits are indeed so largely inclined to the ecliptic that it would be impossible to give any conception of their true position by drawing ellipses or circles on a flat surface. They pass away from the plane of the ecliptic by a distance exceeding that which separates the Earth from the Sun. Thus the only true presentment of the asteroidal system would be one in which each orbit was represented by a circular or elliptic wire properly situated as regards inclination and eccentricity.

In order, therefore, that a diagram representing the asteroidal system may be as truthful as possible, it is well to exclude all orbits which have a greater inclination than five degrees.

Again, many of the asteroidal orbits are very eccentric. When an orbit has an eccentricity exceeding a certain amount, its *ellipticity* becomes perceptible. Therefore to trace down such an orbit as a circle, would be to introduce false relations important enough to vitiate the significance of the drawing. It would clearly be impossible—or, at any rate, very difficult—to draw in a number of ellipses, crossing each other and interlacing. Therefore it is well to exclude all orbits which have a greater eccentricity than 0·15. As this eccentricity may easily be shown to correspond to a very moderate ellipticity,* there will be no important departure from

* An ellipse whose eccentricity is 0·15, has axes which are in the proportion of 1000 to 989, or about 92 to 91.

truth in drawing each orbit as a circle with suitable eccentricity.

The advantage of these omissions is that the resulting diagram may be looked upon as being, so far as it goes, a *truthful* representation of the asteroidal orbits contained in it. There is a disadvantage, of course, in the fact that two very remarkable features of the asteroidal system are omitted; namely, the strange wandering of some of its members from the plane of the ecliptic, and the cometic ellipticity of certain asteroidal orbits. But in this, as in many other cases of this sort, we must be content to illustrate as many features as possible, without hoping to exhibit all.

There is also another reason for making a selection, in the circumstance that even when but few orbits are presented, these form a complicated diagram.

In contemplating the orbits thus drawn, it seems impossible to recognize the existence of any law. One might almost as well attempt, it would seem, to take a tangled web and seek by a few touches to present it as a well-wound skein. The few peculiarities which strike our attention, are misleading, since they have no relation with any such laws as we can reasonably associate with the scheme. For instance, it will be found that in the lower right-hand quadrant there is a remarkable feature in the apparent intersection of no less than five orbits in a single point. In the lower left-hand quadrant, again, there is a much more uniform distribution of the orbits (of all, at least, but one), across the width of the system than in the other quadrants. But these peculiarities are accidental, and are wholly masked when more orbits are drawn in.

Now, how is order to be introduced into all this confusion? It would be a task requiring superhuman patience and abilities to trace back the motions of even a few asteroids, so as to endeavour to discover in some far-off ages a law or system at present undiscernible. Nor is the task one to which our astronomers are invited by the teachings of modern science; since everything yet discovered respecting the solar system points to an epoch millions of ages passed away as that in which the system had its birth.

There is, in fact, only one theory which could render the attempt worth making. On the supposition that the asteroids are the fragments of a primary planet which exploded at some unknown epoch, it might be possible to obtain some evidence of the fact, by tracing back the paths of the asteroids. This theory has been a favourite one with some very eminent mathematicians, and therefore must not be looked upon as unworthy of consideration. It is, however, a

theory which is not merely unsupported by evidence, but seems opposed to all that we have yet learnt respecting the modes in which nature works. And there are certain peculiarities which, were the theory true, could hardly fail to be discernible in the motions of the asteroids. It is not, indeed, true, as is sometimes stated, that if a planet were to burst, the fragments must after a time return *simultaneously* to the place where the explosion took place; and so either coalesce again in a single mass or rebound after the collision, and return again and again for ever to the scene of encounter. But it is strictly true that the *orbits* in which the fragments would begin to travel would all intersect in a common point.* And though the attractions of the other planets would immediately begin to disturb this relation, and would eventually destroy it altogether, yet there could hardly fail to remain traces of its former existence. The question has been thoroughly examined by Mr. Newcombe, an American astronomer; and he has shown that the evidence is altogether unfavourable to the supposition that the asteroidal orbits intersected each other in a common point at any past epoch, however distant.

With reference to any less simple issue, the examination of the probable condition of the asteroidal system in past ages would, as we have said, have been much more difficult. Fortunately Professor Kirkwood is able to point to an actually existent relation which is full of meaning in connection with the views we are to form of the original condition of the system of small planets.

If we look on the asteroidal orbits in relation to their eccentricities or inclinations, to the position of their perihelia or that of their nodes, we see nothing but confusion. But there remains an element of their orbits which may yet exhibit to us the traces of a law. I refer to the mean distance or semi-axis major.

Even here, however, there seems confusion enough. If we could exhibit the major axis of ten or twenty asteroidal orbits, as lines

* It is singular how perplexing and even incredible this circumstance appears to many. It was recently made the subject of quite a series of letters in a scientific periodical. Yet it depends on the simplest of all laws of planetary motion. If a planet is projected from a point in any direction we know that it will travel on a path which will bring it back to the point of projection (we exclude of course the extreme case of parabolic or hyperbolic orbits, which require velocities such has could not have been imparted to the fragments of our supposed exploding planet). What is true of one planet is true of fifty or of a million; so that if a million planets are projected from the same point or region of space their orbits will all necessarily pass through that point or region. It may seem as though I were begging the question in assuming that a planet projected in any direction will travel in a closed curve. But in reality it is not so; because this fact is admitted by the very persons who fail to see the obvious conclusion to which it points.

drawn through the sun, we should detect no trace of any law at all in the order of their lengths. But Professor Kirkwood takes them apart from their relation to the solar system, and simply sets them down in their proper order, in a table. And because the examination of such a table is a slow and tedious process, I have preferred to exhibit the teachings of the table in a graphic form.

The figure then, represents the distribution of the mean distances in a manner which is at once cognisable. If all the asteroidal orbits were reduced to one plane, their eccentricities also being all removed, the figure might be supposed to represent a section of the ring formed by these orbits, but for one circumstance, that properly speaking, all the vertical lines would in that case be curved about a centre on the left, rather more than nine inches from the division marked 3·0. We see at once, that if each orbit were represented by a continuous wire, we should have a figure resembling Saturn's rings, the portions corresponding to the shaded parts of the figure being those within which the wire orbits would be most closely set. If the orbits were made of bright metal, and the system were projected on a black background, we should have a system presenting not merely a general resemblance to the Saturnian rings, but exhibiting particular features of resemblance. For the parts corresponding to the unshaded spaces in the figure, would appear as black divisions between the rings; and, neglecting six or seven single orbits, there would be three well-defined rings, corresponding to the outer, inner, and dark rings of the Saturnian system; while on these several rings there would be less well-marked divisions, corresponding to the dusky divisions in the Saturnian ring-system.

But at present I merely point out these relations to enable the reader to interpret the meaning of the figure. Let us now see what Professor Kirkwood has to say respecting the gaps presented in the asteroidal system as thus exhibited. These gaps might be looked upon by the careless as merely accidental. But in nature few circumstances are accidental; and the true student of nature is prepared to trace in apparently trivial relations the operation of laws which often appertain to the noblest man has been able to discover. The gaps which seem in our figure so trivial, and to be disposed so irregularly, are found to be as full of meaning in their way as the dark lines in the prismatic spectrum.

The mean distance of a planet is usually the most unchanging element of its orbit. The eccentricity is contintally varying, so also is the inclination; the nodes and the apses also are continually

travelling round and round among "the signs." But all the while the mean distance commonly remains unchanged. In one case only is the mean distance subject to change. If it happens that the planet has a period commensurable (according to some simple law) with the period of a neighbouring planet, then disturbances, which in any other case would in the long run produce no effect, because the change worked in one direction at one time, would be corrected by changes worked in a contrary direction at another, come to be cumulative. For example, suppose a planet goes once round the sun while another goes twice round: then when the two are near conjunction certain disturbing effects are produced. When the first comes round to the same place there is another conjunction and the disturbing effects are repeated; and so on, until the continual action of the same process works its own cure by destroying the simple relation of commensurability on which the process depends. But though the disturbances are now no longer cumulative they have worked a marked change upon the mean distances of the two planets; for by Kepler's third law the mean distance bears a fixed relation to the period, and the periods being no longer commensurable as at first, the mean distances must have undergone a corresponding change.

The tendency, then, is for a planet, thus subject to disturbance, to take up an orbit having a mean period incommensurable * with that of the disturbing planet. And if one planet is very small in comparison with the other, nearly all the effects of the disturbance will be exhibited in the smaller body's change of orbit.

Now Professor Kirkwood applies this reasoning, which, be it understood, is not hypothetical but mathematical, to the zone of cosmical particles (or nebulous matter, we know not which) originally existing, according to the nebular hypothesis, where the zone of asteroids is now found. The tiniest particle of matter would travel as steadily in a planetary orbit and with planetary velocity, as Jupiter himself, if undisturbed. But all the particles of the asteroidal zone would be subject to his disturbing action. And as there would be particles at every possible distance from the Sun between certain limits, it is clear there must be some moving in orbits commensurable with Jupiter's. For example, taking the limits of the zone to be those indicated in the figure; that is, that the outer part was about $3\frac{1}{2}$ times as far from the Sun as the Earth is, and the inner part rather more than twice the Earth's distance from the Sun, we find, within

* To avoid needless repetitions I mention that throughout this paper I mean the word commensurable to apply only to *simple* relations of commensurability.

those limits, the mean distances corresponding to the following periods:—

$\frac{1}{2}$	that of Jupiter,	mean distance	= 3·2776
$\frac{4}{9}$	do.	do.	= 3·0299
$\frac{3}{7}$	do.	do.	= 2·9574
$\frac{2}{5}$	do.	do.	= 2·8245
$\frac{1}{3}$	do.	do.	= 2·5012
$\frac{2}{7}$	do.	do.	= 2·2569

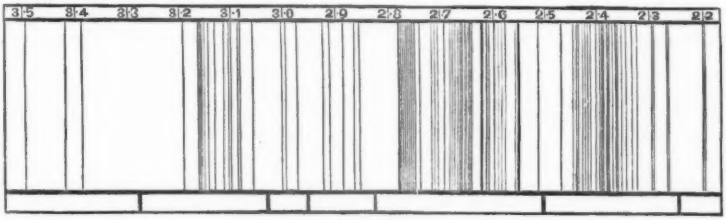
These are all the periods mentioned by Professor Kirkwood, but there are a few others, as, $\frac{3}{8}$ths, $\frac{5}{11}$ths, and so on. I content myself by indicating the existence of these, and mentioning that the calculation of their effects strengthens Professor Kirkwood's case. It would be confusing, however, to consider more in these pages than the circumstances which Professor Kirkwood has especially dealt with in illustration of his views.

Now I must state what is the measure of the *effectiveness* of any simple relation of commensurability. In the cases just cited, we have a fraction $\frac{1}{2}$, $\frac{4}{9}$, or $\frac{3}{7}$, or the like. But the best way to consider the relation is to look upon the numerator of each fraction as indicating a number of revolutions of Jupiter, the denominator as indicating a number of revolutions of an asteroidal particle; and to notice that the times occupied by these two sets of revolutions are identical. Thus we see at once that the full time elapsing before there is a return to the same series of disturbances is always as many revolutions of Jupiter as are indicated by the numerator of the fraction. And it clearly follows that the smaller that numerator the more effectual will the disturbances be in the long run. But we must not neglect another consideration depending on the denominator. It will readily be seen that between the successive returns of Jupiter and a particle to conjunction in the *same* direction, there must have been in general other conjunctions. It will be found on inquiry that the positions in which these conjunctions take place are equally distributed round the orbits, which they divide into a number of parts equal to the difference between the numerator and the denominator of the corresponding fraction. For example, take the fraction $\frac{3}{7}$. This indicates that after any conjunction there will occur another in the same direction after three revolutions of Jupiter and seven of the asteroidal particle; but in the interval there will have been conjunctions in directions which, with that of the first, divide the orbits into four equal parts. There will therefore have been three other conjunctions. And it must be remembered that the greater

the number of parts into which the conjunction-lines divide the orbits, the more equably will the effects of the various disturbances be balanced. This is why only simple relations of commensurability are considered. This also enables us to coordinate the relations according to their various degrees of effectiveness.

And now to return to Professor Kirkwood. He argues that a particle travelling in an orbit having any of the mean distances tabulated above, would be continually more and more disturbed by Jupiter, until freed to travel in an orbit of different period and probably much more eccentric. In either case it would be brought into collision with particles travelling originally outside or inside its orbit.

Hence, considering the effect of such collisions in forming asteroids, we see at once that the resulting bodies could not have orbits commensurable with Jupiter's. For those particles which had not such orbits, would continue comparatively undisturbed, while those which *had* would be disturbed, eventually brought into collision with others which had *not*, and so in the long-run none would exist having such orbits; while the formation of small planets would in every case have taken place at mean distances corresponding to incommensurable periods.



Now let us see how far the actual arrangement of the asteroidal orbits corresponds with these results. Along the lower division of the figure, I have placed dark lines corresponding to the six distances above tabulated. It is at once apparent that they accord perfectly with the gaps in the asteroidal system. All the large gaps are thus accounted for; and the marked but small gaps in the zone, between distances 2·5 and 2·8, accord with some less simple relations of commensurability, not dealt with by Professor Kirkwood, and which need not be at present considered.

The question may be suggested, however, is it not possible that the gaps thus apparent are merely accidental, and their accordance

with the mean distances simply another accidental coincidence? It may seem, at first sight, that we have not as yet determined the orbits of a sufficient number of asteroids, to decide very positively on this point. If another hundred were discovered, it might well happen, one would suppose, that the gaps would be filled up. But, in reality, the doctrine of chances is wholly opposed to this supposition. A law, such as that exhibited in the figure, does not present itself without a cause. Irregularity is to be observed in all chance combinations, and the figure may be said to exhibit irregularity. But irregularities resulting purely from accident, never by any chance (when a fairly large number of cases is taken) simulates, so to speak, the operation of law.* Therefore we may assume that when many more asteroids have been discovered, the law exhibited in the figure will appear even more distinctly.

Thus understood, Professor Kirkwood's discovery appears to me to be one of extreme interest and importance. We have what I hold to be a mathematical proof of the formation of the asteroids from a zone of cosmical matter, whether nebulous or not I need not stay to inquire. We have, in fact, a proof of the operation of those very processes which Laplace had conceived to have been in operation, countless ages ago, in the formation of the solar system. We do not indeed find, that in this special instance, these processes have resulted in the formation of a single planet. Had they done so, indeed, we should have wanted the evidence we are now dealing with. But we see enough to indicate the mode of operation, under the action of which the planets were formed. And in the neighbourhood of so large a planet as Jupiter, we have a circumstance which suffices to account for a variation, at this particular part of the solar system, from the course of events which had, in all other instances, resulted in the formation of a planet.

This at least is Professor Kirkwood's view. My own impression is somewhat different. I cannot but feel that the zone of

* An interesting illustration of this peculiarity lately came under my notice. In a paper called "Notes on Nebulæ," which appeared in THE STUDENT for March, 1868, I had exhibited the appearance of a certain law in the arrangement and distribution of the nebulæ, this law being derived from the consideration of some three thousand nebulæ. Now it happened that Mr. Cleveland Abbe had been at the pains to arrange no less than five thousand and twenty nebulæ, from Sir John Herschel's catalogue, in such a manner, that I could at once apply his numbers to determine if the law I had noticed were still observable. I found, as I had expected, that this was so. Though the number of nebulæ considered had been nearly doubled, there was not a single peculiarity discoverable from the more complete list, which had not been exhibited in the illustration to my paper.

asteroids indicates the occurrence of a definite change in the mode of evolution of the planets. Up to that point enormous quantities of matter had been conglobing into planets with noble systems of attendant orbs; indeed there had been a pretty regular increase from the masses of the giant planets Uranus and Neptune, to the yet vaster Saturn, and to the giant among giants Jupiter. Then the substance of the great revolving disc which had given birth to those enormous bodies seems to have been all but exhausted, so far as the generation of new orbs was concerned. The zone next thrown off, seems to have presented too sparse an array of cosmical particles to form a single planet by the action of its parts in producing continual collisions, and so, with much heat and turmoil, a vast rotating molten or vaporous globe.* With further contraction the disc seems gradually to have recovered its planet-generating powers; for first the small planet Mars was formed, then the Earth with actually an attendant Moon. But there the new effort culminated, the next planet Venus being moonless, and appreciably smaller than the Earth, and Mercury being the last and least of the whole series.

Only one doubt suggests itself as to the completeness of what I will venture to call Professor Kirkwood's proof of the nebular hypothesis. If the asteroids had been originally formed as at present, but with orbits having every variety of distance from the Sun within certain limits, would the action of Jupiter have been capable of generating the present order of things? From a remark in Professor Kirkwood's paper, he seems to think that it would. "Even should a disturbed particle," he says, "not come into contact with other matter, the action of Jupiter would ultimately change its mean distance, and thus destroy the commensurability of the periodic times." What is true of a particle would be true of a planet, and thus Professor Kirkwood appears to destroy the validity of his own proof. But in reality the process he mentions would not be an ultimate one. Undoubtedly, if there were now an asteroid with a period commensurable with Jupiter's, the action of the planet would destroy that commensurability, but after attaining a maximum or minimum period in this way, the asteroid would gradually resume its original period through the action of Jupiter himself, and thus an oscillatory process of change would be continually in operation. We see in fact precisely such a change,

* We *know* in fact that there was a real want of material, since Leverrier has shown that the total mass of the asteroids, estimated by its effect on the apsides of Mars's orbit must be less than a tenth part of the Earth's mass.

under the action of the very law we are considering, in the period of the planet Saturn; and there is no reason for supposing that an asteroid would behave differently, though the extent of the oscillatory disturbances would doubtless be very much greater. This being so, there would be nothing to account for the gaps exhibited in the figure. The only possible explanation seems to be that which involves the nebular hypothesis; for under the processes thus resulting, the disturbed particles would never resume their original orbits, being gathered up into the substance of inner or outer masses.

But perhaps the most remarkable part of Professor Kirkwood's researches is that which yet remains to be considered.

The Saturnian rings have lately been recognised as composed of discrete satellites. Rings thus formed, would clearly be subject to the same processes as the asteroidal zone. For the satellites of Saturn, especially those nearest to the rings, would exercise a disturbing influence corresponding to that which Jupiter exerts upon the asteroids. This being so, it is clear that we might look for zones in which satellites would be wanting, through the effect of the very circumstances we have been dealing with above. Now, we know that the great division in the rings is a permanent feature; and therefore we might expect to find the existence of this division associated by some law of commensurability with the motions of the nearer satellites. Nay, this division is of so remarkable a character that we might fairly expect to find some very remarkable law or laws of commensurability. For, undoubtedly, there must be simple laws of commensurability, associating the motions of the nearer satellites with the motions of the minute satellites in other parts of the ring; and these laws would suffice to account for those faintly discernible divisions which only our best-armed telescopists have been able to recognize. But a division so wide and so strongly marked as Cassini's, requires, one would suppose, something more remarkable than a single and simple law of commensurability to account for it.

This is precisely what Professor Kirkwood has been able to show, and in so doing he has obtained a proof that the constitution of the Saturnian rings is that which has been recently assigned to it by Professors Pierce and Maxwell; and he has also afforded a singularly effective argument in confirmation of the proof of the nebular theory already derived from the motions of the asteroids. Professor Kirkwood's treatment of the question is summed up in the following table:—

	H.	M.	S.
The period of a satellite revolving at a distance equal to the interior limit of Cassini's division is .	10	52	11
$\frac{1}{6}$ of Dione's period is	10	56	53
$\frac{1}{3}$ of Enceladus's	10	59	22
$\frac{1}{2}$ of Mimas's	11	18	32
$\frac{1}{4}$ of Tethys's	11	19	36
The period of a satellite revolving at a distance equal to the exterior limit of Cassini's division is .	11	35	18

Thus we see that not one law, but four laws of commensurability, each very simple, and therefore very effective, operate to keep the great division clear of the minute satellites which form the rings.

It would not be easy to exaggerate the importance of Professor Kirkwood's researches. Founded as they are, not on speculative fancies, but on the well-established laws of planetary motion, they are worthy of the closest attention. I believe they will inaugurate new and important processes of thought, by means of which the noble but hitherto intractable problems connected with the formation of the solar system may be found capable of solution.

THE MINUTE NERVE-STRUCTURE OF THE HUMAN EYE.

BY DR. MANN.

Mr. Hulke has recently been delivering a series of lectures on the structure of the eye, at the Royal College of Surgeons, in Lincoln's Inn Fields. The course was brought to a close a few days since by a very elaborate and interesting description of the minute nerve-structure of the organ, in which the lecturer ably demonstrated pretty well all that is known at the present time in this still somewhat mysterious and recondite branch of human anatomy, and in doing this had to deal somewhat with paradox, and to indicate the road to further investigation. The field, indeed, is a peculiarly rich one, both in suggestion and in material for philosophic thought.

The lecturer dwelt very lucidly, and with some measure of professional relish and affection, upon the delicate mechanism by which an exquisite physical impression seems to be transmuted into a yet more exquisite vital action. He traced out, by the combined power of a pictorial hand and tongue, the way in which vesicles, and fibres, and prisms are piled into successive layers, baccillary, outer, inner and intermediately, and finely, granular; nerve-vesicled, nerve-fibred, and limitary, and the rest. All of which, however, when reduced to ultimate simplicity, simply means that into this wonderful organ nerve-fibrils run on end, and are then bunched with ripe-nerve vesicles, somewhat as the fruit stalks of a vine are bunched with ripe grapes; the vesicles, however, being grouped more or less into interrupted layers, and the whole thickness of nerve-vesicle and nerve-structure being bound together by transverse bands of non-nervous fibre, or connective texture. On one side this remarkable mesh of organized fabric is defended by a compact "limitary membrane" of inwoven fibres. On the other side it is pavemented by a layer of rods, or prisms, imbedded upon the subjacent texture, somewhat as the wood prisms are imbedded upon the subjacent surface in one particular method of paving the streets. These prisms, or rods, are fairly held to be the essentially physical parts of the structure, because they are "optical" in character and look; straight-sided, regular, rigid, and exact; instead of being vital and physiological of aspect, like the subjacent granular and vesicular layers. There is, however, also an intermerdiate and debateable ground of considerable interest, where a series of bulbous expansions, or "cones," connect the physical domain of the rods with the physiological domain of the granules and vesicles, in which the transmutation of the physical into the vital action is presumed, most rationally, and in all probability correctly, to be effected. There is obviously a very delicate and subtle fibrous connection between the cones which lie on the threshold of the physiological domain, and the outer granules which are within its pale. A fine fibre passes from the granule, through a sort of outer limiting membrane, into the pointed extremity of the cone; and this fibre has been described by some observers as being carried on into the prism, or rod. The cones, however, fall asunder very readily from the prisms; their connection with them is very frail and slight. In the eyes of many birds the exact points of connection are "jewelled" by beads of very remarkable and brilliant colour; but these optical gems are not found in the more sober and prosaic eyes of man. This is pretty well all that the microscopic anatomist is able to

tell regarding this wonderful piece of elaborate living organization.

But the inquirer does not reach even this stage without coming across paradox. He has had clearly displayed before him a beautiful structure spread into a broad membrane in which there are tubes, or prisms, for the reception of light-beams on one side, and nerve-vesicles and fibres, to be acted upon vitally by the rays that are received by the prisms, at the other side. When this plan of arrangement is first perceived, it is very naturally anticipated that the prisms which receive the light are on the outer side of the fabric, and that the vital vesicles and fibres, are on its inner side. This, however, strange to say, is not the case—the nerve-structures are on the outer side, or that upon which the light first strikes in the interior cavity of the eye, and the optical prisms are on the inner side. The eye, *in regard to its intimate internal structure*, is not like a camera in which the opening of the window is in front, and the ground glass screen for the painting of the picture at the back of the dark chamber. The arrangement is virtually just reversed. The opening of the window is behind, and the screen in front, and the light has to pass clean through the screen to the window, and has then to be thrown back from it, upon the posterior surface of the screen. The whole of the granular, vesicular, and fibrous layers, which form the vital portion of the organ, are so exquisitely transparent that the light passes freely through them, as it would through the clearest film of glass, then strikes into the closely ranked tubes and prisms, and reaches their bottoms; but finding no outlet there, rebounds upon the nerve-structures it has just permeated, to be felt by them in its reflected and spent ball like state as sensation. Why it is that vision is thus brought about by this rebound, and back-stroke influence of luminous vibration, no one can say. No one can tell how it is that the light rushes through the sentient nerve membrane in its first direct course without exciting visual perception in it; or why on its return-course, or rebound, it does not again pass through in the same unperceived way. The prisms and the cones no doubt contain within their walls the explanation of the mystery. It is, unquestionably, by their instrumentality that light is changed into "sight," and no doubt the back-stroke action that looks so paradoxical to the uninitiated observer is part and parcel of the ways and means. In some wonderful way the prisms absorb the physical energy that traverses the million-mile chasms of space in almost unmeasurable instants; and convert its spent-force rebound into vital feeling. But *in what way*

the marvellous transformation is brought about, neither optician nor physiologist, can yet declare.

The prisms (or rods and cones) associated with the vital nerve-structure of the human eye have been conceived to be each a complete piece of optical apparatus in itself; a virtual camera obscura, or dark chamber, in which the cone plays the part of lens, and the prism, or rod, the part of opaque walls.

It is worthy of remark that in the eyes of some creatures lower in the scale of organization than man, the walls of these prisms are coated inside with a dark pigment, much as the cavities of artificial cameras are painted with lamp black, to prevent confusing dispersions and reflections. In the human eye the dark absorbent coating is dispensed with, mainly because the cavity of each prism is so narrow and long, that the dispersions and reflections which would have room for play in wider quarters are stifled for want of space. In the human eye the isolation of each separate stroke of light appears to be secured by the refined delicacy of the optic part of the apparatus, rather than by the blackening of the tubes. That, at any rate, is at the present time the explanation of the anomaly offered by physiological ingenuity. In this particular also, there is, most probably, room for further investigation.

It is hardly possible to contemplate this curious apparatus of prismatic chambers pavementing the interior surface of the nerve-coats of the eye, without being forcibly struck with its intrinsic resemblance to the chambered structure of the compound eyes of insects, in which a faint mosaic of external nature is laid down in light by sifting and sorting the parcels of rays in the precise order in which they are thrown from the external objects that are distributed around. In all probability the eye of man is a compound eye with a difference: the coarse elementary type of eye-organization extended and perfected by additional contrivances.

In one part of the seeing nerve-membrane spread out around the interior of the human eye, there is a spot which is deserving of a separate and an especial notice. It looks, at first glance, like a pit or depression, in the woven fabric. It lies near the centre of the concave eye-ball, and it has thence been designated the "fovea centralis." The cause of the pit is simply that the substance of the woven membrane is here thinned away. This effect, however, is produced merely by the removal of the granules and fibres, and coarser elements of the structure. The remaining portions, the prisms and cones, and nerve-vesicles are smaller and finer than they are in other parts of the membrane, and they are proportionately

more numerous, and more closely packed together. Indeed, they are more delicately and more exquisitely organized, and on that account perform their appointed task of seeing with finer precision and finish. This portion of the eye is accordingly employed when any extraordinary effort of vision has to be made. There is neither paradox nor uncertainty about the nature of this spot. Its character is well ascertained and thoroughly understood. The seeming speck is in reality a tract of refined finish and perfection, in which the optical and vital structure of the organ is raised to the highest strain of perfection. The coarser portions of the fabric are drawn away, and the finer portions, and more essential elements, are further refined and vitalized. The "central pit" is in reality the "microscope of the eye"; the part of the organ which is drawn upon for all its most exact, and delicate, and exhaustive operations.

The "fovea centralis" of the human eye has, however, an indirect bearing upon a paradox, although unparadoxical in itself. The discovery of its character and structure suggests a complete explanation of a matter that has puzzled some of the most intelligent and distinguished opticians of the day. The puzzle, reduced to its simplest form of expression, is this,—If, in the deepening twilight of the evening, a telescope of considerable aperture and low power is directed to the face of a clock when the figures and hands of the dial have already become quite invisible to the unaided eye, they become perfectly plain again as if more light had been thrown upon them. The telescope is a *faint-seeing* as well as a far-seeing instrument. The reason for this is that the telescope virtually enlarges the aperture of the eye that avails itself of its co-operation. The comparatively large aperture of the instrument gathers in additional light, and so paints the image within the eye with proportionally augmented brilliancy and splendour. But if, in faint twilight, an optical lens of high power, which really augments the size of the visible picture very much more than it adds to its illumination, be employed in looking at an inconspicuous object, the same result ensues. The print of the "Times" newspaper can be distinctly deciphered by a very small and very powerfully magnifying lens of glass when no trace of the letters can be discerned by the unassisted eye. Now the explanation of this curious and unanticipated fact is physiological rather than optical. When a powerful magnifying glass is used in looking at a small faint object, the picture of that object is spread over a very much larger surface on the membrane within the eye. Consequently,

thousands instead of hundreds of the minute prisms and nerve-fibres of the organ become engaged in the work of discriminating the details and features of the delineation. The increase of nerve power enlisted in the effort to see, virtually has the same effect as increasing the force of the stimulus. Vital energy is brought into action to compensate for the deficiency of the physical impacts. When a powerful lens is used to assist vision, the entire surface of the nerve-coat of the interior of the eye is for the time being practically converted into a fovea centralis. A larger number of the visual prisms and fibres are caused to perform the particular work on hand, and the work is accordingly more delicately, completely, and exquisitely accomplished. By the use of the lens the entire eye is converted into a microscope. All parts of its seeing membrane become endowed with the superior powers which otherwise belong to the "central pit" alone.

Allusion has been made to the strong probability that the conical appendages of the rods or prisms of the human eye are the material instruments concerned in the transmutation of physical impact into vital action. There can be no doubt that these little bodies are very important parts of the organ in eyes fitted for the most perfect kind of vision. Eyes can, nevertheless, be made without them. They are entirely absent in the eyes of night-prowling animals like the owl and the bat. The inference is hence very fairly drawn by some of the German physiologists, that the sight of these nocturnal creatures must be wanting in some of the higher attributes of the sense. As it is not possible to bring the owl and the bat into the Court of Scientific Inquiry to give evidence upon this point, the great experimentum crucis of all the more occult and subtle difficulties of vital organization, pathology, will have to be appealed to. In all probability some day an owl-eyed or a bat-eyed human being will be discovered who will be able to tell how external nature looks to "coneless" eyes. Possibly Schultze's idea that such eyes see everything in monotonous white and black shadow may be near the truth.

NEW NICKEL COINAGE FOR JAMAICA.

BY JOSEPH NEWTON.

We have been favoured with an inspection of some new coins which are, or were very recently, being struck at the Royal Mint, Tower Hill, for circulation in the Island of Jamaica. They are composed of a metal which is rapidly increasing in favour for coinage purposes in many European States, and in America—namely, nickel. There is no doubt that this substance is peculiarly adapted for use among the sable subjects of Her Majesty, who have, for very good reasons, a hatred of copper, or bronze money. These metals (and copper more especially), when brought into contact with the moist hand of the negro, become speedily oxidized and tarnished, and emit, under the circumstances, a very unpleasant odour. It is even said that they produce cutaneous eruptions on the digits of the poor Africans, and thus add another to the many social disadvantages under which they labour.

At any rate, there is no question as to the fact that the native population of the West India Islands detest the subsidiary coinage —pence, halfpence, and farthings—of Great Britain. For very many years past, therefore, it has been the practice of the successive Governments of this country to accommodate the inhabitants of Jamaica, and of other of our possessions in the West Indies, with a distinctive coinage, in the form of three-halfpenny pieces of silver. Many tons' weight of these pretty little coins, which may be described as miniatures of the English shilling—in all respects except the imprint of value on the reverse side—have been from time to time produced at the Royal Mint, and forwarded to those places. These tiny specimens of mintage have been found exceedingly acceptable, and doubtless are very useful, to the people for whose particular benefit they were struck; but, as may be imagined, they have not met all the requirements of the case. The minor transactions of trade in this more favoured land could not be carried on, without great difficulty, if the lowest denomination of coin in circulation were the three-halfpenny piece. The evil must necessarily be far greater among a poorer population, and where the traffic descends to a level of which we happily have no experience.

It is for these reasons, therefore, that the present Government has determined to issue an experimental coinage of pence and halfpence—to be followed, probably, by one of farthings and half-farthings—composed of pure nickel, for the colony of Jamaica.

The specimen coins of the two first-named denominations present an appearance, both as regards colour and design, very superior to that of the bronze currency circulating at home. In fact, their similitude to silver money, at the first glance, is rather startling. The impressions which ornament the nickel pieces are, however, totally different from those which distinguish either denomination of silver coin in the British series.

The diameter of the new Jamaica penny is $1\frac{3}{16}$ inches, and its weight $\frac{1}{48}$th of a pound avoirdupois. The obverse presents an admirable representation in profile, and regarding the left, of the head of Her Majesty. The impression is not cut in very bold relief, but the outline of the engraving is distinct and well-defined—characteristics which should distinguish coins generally, but which have been sadly overlooked in the decoration of the gold and silver coins of Great Britain. The portrait of the Queen is excellently delineated, and the matronly character given to it contrasts favourably—from its truthfulness to nature—with the juvenile features of Her Majesty given on our sovereigns and shillings. The royal brow is decorated with an elaborately engraven diadem, the hair being arranged in classic style, and gathered in what is vulgarly known as a "knot" at the back of the head. The ends of a riband, supposed to affix the diadem, fall gracefully over the neck. An inner and finely-dotted ring encircles the portrait, and between it (the ring) and the ingrailment of the protecting edge of the coin is the simple legend "VICTORIA, QUEEN," and the date "1869," the latter having a rosette placed before and after it.

The reverse of the nickel penny is of a more composite description, and indeed gives to the piece a distinctive and appositely colonial character. Within a dotted inner ring or circle of beads on the table of the coin the arms of the Island of Jamaica are depicted. These consist of a shield, spanned vertically and laterally by a matted cross, upon which are represented four pineapples indicative of the warm climate and rich vegetable products of the dependency. The four quarters of the shield formed by the cross are quite free from ornamentation of any kind, and thus tend to relieve the rich figuring of the remainder of the design. A riband below the shield bears upon its gracefully interwoven folds the motto, "*Indus uterque serviet uni.*" Surmounting the shield, and placed on a ground line drawn immediately over it, is seen an object far less attractive than a pineapple, although, like it, suggestive of the peculiarities of Jamaica—it is the image of an alligator! The inscription on the reverse, and between the inner and

outer beaded circles, is a model of brevity and simplicity. It is entirely comprised in the words—"JAMAICA; ONE PENNY." The nickel halfpenny is a reduced *facsimile* of its relative in all respects but the nomination of its value; and the complete designs for both, as well as the engraving of the dies, are the work of Mr. Leonard C. Wyon, upon whose artistic skill and manipulative talent the new coins reflect credit.

The diameter of the halfpenny is exactly one inch, and its weight is $\frac{1}{80}$th of a pound avoirdupois. It can scarcely be doubted that the money will find favour at the hands of those for whose benefit it has been created; and, since nickel is nearly as hard as iron, its resistance to abrasion, and consequent durability, are unquestionable. The specific gravity of the metal varies from 8·28 to 9·00. It melts at a lower temperature than iron, but is nevertheless difficult of fusion. The natural colour of nickel is white, with a yellowish tint. The impressions upon both pence and halfpence, though not, as has been observed, of great depth, demand the application of great force for their perfect development, owing to the obdurate character of the material.

THE NUTRITION OF PLANTS: PERIODS AT WHICH THEIR CHIEF ELEMENTS ARE ASSIMILATED.

BY M. J. ISIDORE PIERRE.

("Comptes Rendus," No. 26, 1869.)

AMONGST the questions, the solution of which is of most importance to the agriculturist and the gardener, we may place that of determining approximately, if not rigorously, the epoch at which each plant absorbs for its nutriment the different elements of which it is composed. Such a determination would enable us to supply the plant at the opportune time with its necessary aliments, or at least with those which are under our control, just as we furnish our farm-yard animals with the food best adapted to them. From a complete solution of this fundamental question numerous important consequences would flow, amongst which we shall confine ourselves to the following:—1. At what epoch of the life of a plant do manures act most efficaciously in furnishing a portion of its substance, and from what stage of its vegetation is their direct action almost *nil*; or, in other words, at what period may the earth usefully receive, and

utilize for the profit of the crop, fertilizing materials? 2. At what stage of its vegetation does a plant seem to cease extracting from the soil all or a part of the elements which must enter into its composition; in other words, up to what period does the plant go on exhausting the soil, and when does this process reach the maximum of activity?

Let us first limit the inquiry to a single plant, *wheat*, and we shall subsequently see that we may extend to other plants the conclusions we shall arrive at. The most suitable means of elucidating the question is to follow, step by step, the variations which the plant undergoes in total weight and chemical composition in the course of its development, and note the successive additions to its organic materials and mineral elements, and we shall thus discover at what moment this augmentation takes place with the greatest rapidity, when it slackens, and when it ceases altogether.

As analyses of this nature are long and difficult, I found it necessary to limit their number, and to choose suitable epochs of observation. Those of the first series were made in 1862.

On the 19th of April, when the stems began to elongate.

May 16, when, if the upper leaves were carefully unrolled, the ears could just be distinguished and separated.

June 13, when the ears began to appear.

June 29, when the ears were completely deflowered.

July 13, when most of the ears began to turn yellow.

July 30, at harvest-time.

My second series of observations were made in 1864.

May 11, before earing, when the wheat was a little more advanced than on May 16, 1862.

June 3, earing-time, rather more advanced than on June 13, 1862.

June 22, end of flowering, the corn being nearly in the same state as on June 29, 1862, or perhaps a little forwarder.

July 6, grain easy to separate.

July 25, harvest.

The plants did not always contain the same proportion of water, which made a comparison of weights difficult. To avoid this source of error I desiccated all the specimens.

The harvest of 1862, calculated with reference to a hectare, gave the following results—

	April 19. Kil.	May 16. Kil.	June 13. Kil.	June 29. Kil.	July 13. Kil.	July 30. Kil.
Organic matter* .	888·0	2141·1	4962·5	6083·0	6520·9	6510·5
Nitrogen . .	35·8	57·8	72·6	73·2	68·7	67·8
Silica . . .	25·2	67·2	153·7	192·0	203·8	206·6
Oxide of Iron† .	1·3	9·3	14·2	20·5	14·8	15·8
Phosphoric Acid .	7·2	13·5	16·7	18·3	17·4	18·8
Lime . . .	14·8	26·1	37·6	38·0	40·3	32·3
Magnesia . .	2·7	6·3	7·4	8·0	7·0	7·5
Potash . .	16·3	22·6	37·2	42·7	33·2	32·7
Soda . . .	3·9	4·2	8·2	9·7	9·5	5·7
Total . .	995·2	2348·1	5310·1	6485·4	6915·6	6897·7

The harvest of 1864, considered as before, but supplied by a different field, gave the following—

	May 11. Kil.	June 3. Kil.	June 22. Kil.	July 6. Kil.	July 25. Kil.
Organic matter* .	1239·3	2787·8	5309·1	5743·3	5731·6
Nitrogen . .	50·9	52·1	89·9	84·6	78·6
Silica . .	35·3	67·3	127·8	104·0	108·8
Oxide of Iron† .	5·6	5·2	6·9	6·9	5·9
Phosphoric Acid .	9·8	11·9	18·7	17·7	16·2
Lime . .	17·5	21·7	31·3	28·6	23·8
Magnesia . .	3·5	3·7	7·5	6·7	7·5
Potash . .	22·0	23·4	27·0	27·9	23·5
Soda . . .	13·8	21·0	24·5	20·6	14·8
Total . .	1397·7	2994·1	5642·7	6040·3	6010·7

These two tables show that at the close of the period of flowering the plant has acquired almost all its weight; and it has especially taken up those mineral substances which it should contain at maturity. This saturation not only is true of the whole group of mineral constituents, but of each one separately, nitrogen, phosphoric acid, potash, etc.

If, by means of the data which these tables supply, we calculate the mean daily growth of weight for each interval between two observations, we find that it is at the same epoch, namely towards the close of flowering, that the daily increase is most rapid and most considerable, not only as regards the entire plant, but also as regards its most important constituents: nitrogen, phosphoric acid, potash, magnesia, and lime. Thus we see that either the plant maintains an equilibrium between the materials it absorbs and the materials it expels, or else it ceases to extract from the soil and absorb fresh

* Deducting nitrogen and ashes. † With traces of manganese.

nutriment, and performs a sort of slow digestion on what it has already collected, bringing the various substances to the condition required for their ultimate destination, and distributes to its principal organs what they require for their functions and their development. If, as everything lead us to believe, the second hypothesis is nearest the truth, the active intervention of manures, or of elements furnished by the soil must from this period be reduced to a trifle, if it is not absolutely nothing. Fresh additions of manure from this moment can render little service to the harvest. In other words, from the end of the flowering, from the moment when the grain is already formed, addition of manure is unseasonable, or even noxious. Experience has indeed long taught the cultivator that this is not the time to manure lands nor even to give top dressings.*

Do the observations with regard to wheat apply to other plants? We possess as yet few data on the composition of plants at different periods of their life, and different states of development, but I may borrow an illustration from what occurs in the growth of colza, on which I made several observations. The first was made on the 22nd of March, when the plant had reached half a metre, and was near the flowering point. The second was on the 2nd of April, when the plant had reached about a yard in height, and was in flower. The third was on the 6th of May, the plant had reached a height of about 1·22m., and the flowers had completely faded. When the fourth observation was made the plant was about 1·36m. high, and the seed was much advanced. Lastly, on the 20th of June, at the harvest of the crop, all the leaves had fallen and the silicles had begun to turn yellow. I found the following to represent the composition of colza at successive epochs. The roots are not included, the plants were dried, and the calculation made with reference to a hectare.

	March 22. Kil.	April 2. Kil.	May 6. Kil.	June 6. Kil.	June 20. Kil.
Entire crop . .	289·6	339·3	717·2	804·5	800·5
Mineral ash . .	338·7	393·3	853·9	806·9	578·1
Nitrogen . .	77·6	82·4	121·7	116·7	111·1
Phosphoric Acid .	30·8	37·0	73·0	73·6	78·1
Lime . . .	95·6	112·2	259·9	255·0	175·9
Magnesia & Alkaline Salts . .	139·3	152·3	259·9	213·3	209·6

* I have vainly endeavoured to discover in the plant, considered as a whole, whether the different mineral elements entering into its composition accumulate with different degrees of rapidity at different periods of observation. I found myself in the presence of inequalities, which was doubtless dependent on circumstances of which it is impossible to give exact account.

Thus, as with wheat, we find that the plant when its flowering is over possesses nearly all its organic materials, and all its nitrogen and mineral constituents. If we consider that these two plants belong not only to very different species, but to families remote from each other—graminaceæ and cruciferæ—we may consider that the facts above specified have a wide bearing.

We may therefore conclude that up to the moment of forming the ear, and even up to the time of flowering, manures can exert an energetic influence. At the close of the flowering, when the grain is formed, manures whether old or freshly added, have no sensible effect upon the crop.

Among the practical consequences which seem to flow from the preceding results, one of the most important is that it is not necessary for crops to have arrived at maturity in order to exert their greatest effect in exhausting the soil. It would also appear that the organic matter, properly so-called, that is, the carbonaceous matter, has not reached its full limit of growth when the plant's supply of mineral matter is already complete. As regards this ulterior supply of carbon, it may come from two distinct sources; the soil, which furnishes free carbonic acid dissolved in the sap, and the humic materials which the sap can dissolve; the atmosphere, which brings carbonic acid within reach of the leaves for them to decompose it. The assimilation of the carbon by the roots during this period of the life of a crop probably takes place while it is in some state of solution. Carbonic acid in aqueous solution dissolves a certain quantity of mineral matter, the weight of which ought to augment that of the crops, while, on the contrary, there is evidence of diminution. The same observation may be made with regard to the absorption of humic matters in a state of solution, as they always contain a notable proportion of mineral ingredients. There remains the carbonic acid of the atmosphere, one part of which may be exhaled by the soil, by which the vegetation profits. Let us admit that the active portion of the crop represents at this epoch a weight of fifty centimetres, corresponding on a hectare to a stratum of air containing 5000 cubic metres. Let us also admit that the air only contains a mean portion of $\frac{5}{10\,000}$ of its volume of carbonic acid gas, and that half this is decomposed for the benefit of the crop. This decomposed carbonic acid will represent in volume—

$$5{\cdot}000+0{\cdot}00025=1{\cdot}25\text{mc.}\,;\ \text{or in weight}$$
$$1{\cdot}25+1{\cdot}52+1{\cdot}3\ \text{kil.}=2{\cdot}45\ \text{kil.}$$

If the air were removed twenty times a day we should then have a fixation of the carbon contained in about 50 kilogrammes of carbonic

acid, or 0·2727+50=13·63 kil. of carbon, since 100 kilogrammes of carbonic acid contain 27·27 of carbon. If we recollect that the carbon does not represent half the organic matter, we see that upon this hypothesis there may be a daily production of at least 27 kilogrammes of organic matter, which for the fortnight following the deflorescence of the wheat will be about 400 kilogrammes per hectare, of real growth; and for colza this production of organic matter in the month following the deflorescence will amount to about 800 kilogrammes, which closely corresponds with its real growth.

WOMANKIND:

IN ALL AGES OF WESTERN EUROPE.

BY THOMAS WRIGHT, F.S.A.

CHAPTER XVI.

CONTINUATION OF THE ELIZABETHAN AGE TO THAT OF CHARLES I.

THE social history of the reign of James I. was but a continuation of that of the Elizabethan period—we might say Elizabethan debased, in most senses of the word. The love of vanity and display which characterized the former remained undiminished; but the highmindedness, the feelings of honour and probity, the respect for the higher qualities of Womankind, were very much diminished under the influence of the rather loose morality of the Scottish court. Scandals like that of the Earl of Somerset and the Countess of Essex, in which Womankind made no respectable figure, were too characteristic of James's reign. But it is the object of the present chapter to trace outward forms, rather than the moral sentiments of the age.

I have already pointed out the complete change which had taken place in the forms of society, and indeed in social manners generally, especially in England, between the fifteenth century and the sixteenth. This change, no doubt, extended to a great variety of little circumstances, which it would be interesting to trace. It has been stated in a former chapter (see THE STUDENT, vol. iii., p. 20) that previous to the sixteenth century, women, when riding, always sat on the right side of the horse, instead of the left, with the left hand

to the horse's head. We have no record of the exact period at which the change took place. The old custom appears to be traced to the reign of Henry VIII., whose two daughters, Mary and Elizabeth, were both queens of England, and had, therefore, great seals, on one side of which the queen is represented on horseback. Both are seated on the left side of the horse, as at present. My conjecture was, therefore, probably correct, that this change took place in Henry the Eighth's reign. The figures of the two queens, as they appear on their great seals, are given in the accom-

QUEEN MARY AND QUEEN ELIZABETH.

panying cut. They form rather good illustrations of the ladies' riding dresses in the two reigns.

We have seen in the same chapter examples of the ponderous waggon-shaped carriages, drawn by a team of lumbering horses, which were allotted to the ladies during the Middle Ages, and were still in use till late in the fifteenth century. New forms brought in new names, and the ladies were no longer carried, as heretofore, in cars or chars, but in *coaches* and *carroches*. Nares, I know not on what authority, states that coaches are said to have been first brought into England in 1564, by William Boonen, a Dutchman, who became coachman to Queen Elizabeth. The "Nomenclator" (Junius, by Higins) interprets the Latin *pilentum* by "a stately waggon for ladies and gentlewomen: *a coch.*" The "Nomenclator"

was printed in 1585, and, as the name does not occur in that book, we are justified in believing that the carroche was not known in England at that time. Both, as well as the names, *coche* and *carosse* in French, *coccio* and *carróccia*, or *carrozza*, in Italian, were, no doubt, derived from Italy through France. Cotgrave, in 1632, explains *carosse* as "caroach, or great coach;" and Ben Jonson, as quoted by Nares, speaks of "the *great caroch*," with "six horses, and the two coachmen." The Italian word is no doubt derived from *carro*, a car or char, reminding us of the bulky ladies' carriage of the Middle Ages. It was doubtless larger than the coach, and John Cooke, in his play of "Green's Tu Quoque," printed in 1614, speaks of the coach as being then considered more appropriate to the country, and the carroche for London.

> Nay, for a need, out of his easy nature,
> May'st draw him to the keeping of a *coach*
> For country, and *carroch* for London.

In a contemporary painting, of which an engraving was made in the last century by Vertue, Queen Elizabeth is represented in her state carriage in front of Nonsuch House in Surrey, and among her crowd of attendants is another carriage, of much less pretentious character, filled with ladies. The latter is represented in our cut.

A LADIES' CARRIAGE IN ELIZABETH'S TIME.

As at the time it was drawn the caroche appears not yet to have come into fashion, and as it has only two horses—not six, like Ben Jonson's "great caroch"—we may probably consider this as a coach of the Elizabethan period. The name of *coach* has lasted to our own times; the carroche appears to have gone out of fashion in the course of a few years, and we hear no more of it. But the

satirists of the reign of James I. complain of the extravagance displayed by the ladies in their coaches and carroches.

Extravagance in every object of luxury had, indeed, been increasing since the reign of Henry VIII., and only experienced a check on the overthrow of royalty itself. This was especially shown in the great increase of domestic furniture, both in quantity and in its richness and value. Pageantry, and tilts, and tournaments, the last empty shadows of feudalism, were also carried on with greater extravagance and display than ever, though they began to decline rapidly during the reign of James. With these were held up all the forms at least, if not much of the real spirit, of the ancient chivalry. In the tragedy of "Gorboduc," written in the reign of Elizabeth, a "noble prince" is reminded how often, in these tournaments, he had been seen "mounted on his fierce and trampling steede"—

> Shining in armour, bright before the tilte,
> And with thy mistress' sleeve tyed on thy helme,
> There charge thy staffe, to please thy ladie's eye,
> That bow'd the headpiece of thy friendly foe.

The tournaments always ended in banquets and dancing, and pageantry of all kinds, which involved an extravagant expenditure of money. It is the old practice, which we have already seen carried on to such a fatal extent on the continent, of the princes and nobles reducing themselves to poverty by their mad passion for display. It was in one of these tournaments that James met with his favourite, Robert Carr, afterwards Earl of Somerset.

During the reign of Queen Elizabeth the fashions in dress went through continual changes; in fact, they were almost always on the change, and two dresses of the same date often bore little resemblance to each other. At one time the extravagance of the farthingale costume seemed to be passing away; but towards the end of Elizabeth's reign farthingale and hose became more prominent than ever, and they were continued, with hardly any change, into the reign of James I. The extravagance in dress of this reign was often made a subject of satire by contemporary writers. The following description of the labours of dressing a fine woman, though it has been given more than once by writers on this subject, will bear repeating; it is taken from a play entitled "Lingua," printed in 1607, and it may be premised that half-a-dozen maids are employed in the process. "There is such a doing," we are told, "with their looking-glasses, pinning, un-

pinning, setting, unsetting, formings, and conformings; painting blue veins and bloomy cheeks; such a stir with sticks, and combs, cascanets, dressings, purls, falls, squares, busks, boddices, scarfs, necklaces, carcanets, rabatoes, tires, fanns, palisadoes, puffs, ruffs, cuffs, muffs, pusles, fusles, partlets, frislets, bandlets, fillets, croslets, pendulets, annulets, amulets, bracelets, and so many lets, that yet she's scarce dressed to the girdle; and now there is such calling for fardingales, kirtles, busk-points, shoe-ties, etc., that seven pedlars' shops, nay, all Stourbridge fair, will scarcely furnish her. A ship is sooner rigged by far than a gentlewoman made ready." The joke about the *lets* was not new. John Heywood, at the beginning of Elizabeth's reign, in an interlude entitled "The Four P's," two of the P's being a pedlar and a pardoner, makes the latter ask why—

> Women, after their uprising,
> Bee so long in their appareling?

To which the pedlar replies—

> Forsooth, women have many lets,
> And they be masked in many nets,
> As frontlets, fillets, partlets, and bracelets,
> And then their bonets, and their poynets.

It would appear that between this time and the beginning of the reign of James I., the number of lets or hindrances had considerably increased.

The costume of a fine gentleman and lady of the reign of our first king of the house of Stuart is well displayed in the pictures, copied in our cut from a print of the time, of the too notorious characters, the Earl and Countess of Somerset. The lady wears a cap of rich lace, of the fashion well known as a favourite with Mary Stuart, ornamented by a valuable jewel placed in the middle of the forehead. Two rows of necklaces surround her neck, one with pendents. Her ruff, which is of point lace, differs from those in the preceding reign in not being supported by props, but stiffened with starch. The countess's farthingale is of enormous size, exceeding in this and its ungraceful stiffness, the same article of dress as it was worn in the days of Elizabeth. A peculiarity of this dress, too, is presented in the long pendents attached to the sleeves. The earl's doublet, it will be remarked, is equally tight-laced with that of his lady, and his richly embroidered trunk-hose are quite as conspicuous as those of the preceding reign. Two other articles of the male dress are especially characteristic of the period: the garters,

which presents the form of a sash tied in a bow, and the large roses on the shoes. Ben Jonson, in his comedy, "The Devil is an Ass," speaks of "Garters and roses, fourscore pound a pair." Rowland, one of the writers of satirical verse of that time, calls the laced doublet a "monkey-waiste." The dressing of the lady's head was, during all this period, a very long and laborious process, and

THE EARL AND COUNTESS OF SOMERSET.

in the reign of James, as in that of Elizabeth, the use of false hair, curling it, and painting the face, were largely indulged in. The dramatist Massinger, in his "City Madam," speaking of the change which took place in the city dame after her husband was knighted, says:—

> The reverend hood cast off, your borrow'd hair
> Powdered and curled, was by your dresser's art
> Form'd like a coronet, hang'd with diamonds
> And richest orient pearls.

The principal characteristics of the costume I have been describing did not outlive the reign of James. In that of his son and successor there were no more farthingales, trunk-hose, laced doublets, or ruffs. The laced doublet, or stays, was retained only by the fair sex, and the farthingale made its reappearance at times under such names as hoop-petticoats in the last century, and crinolines in our own time. The two accompanying cuts are

GENTLEWOMAN OF THE REIGN OF CHARLES I.

LADY OF QUALITY IN THE REIGN OF CHARLES I.

selected from Hollar's collection of pictures of Englishwomen, as they dressed and looked in the year 1645, entitled "*Ornatus Muliebris Anglicanus*," and may be considered as fair examples of the ladies of the reign of Charles I. The first represents an ordinary gentlewoman, the lady of one of those old manor-houses which are still scattered over many parts of our island; the second is a lady of quality of the same date. We are surprised at the contrast offered by these figures to those we have been describing in the reigns of Elizabeth and James I., and especially at the character of plainness seen in that of the gentlewoman. This plainness, or we may say soberness, was general during the period at which we are now arrived, as may be seen in the numerous engravings by Hollar. The hair of the

second lady is combed back over the forehead, and is allowed to flow freely in curls at the sides. The ruff and the farthingale have entirely disappeared, and the doublet only, or body, of the Elizabethan dress, less tightly laced, remains.

One custom of the Elizabethan period is retained by both these figures: that of carrying a fan of feathers, which in both cases appears to be hung to the waist. Masks, too, still continued to be worn by women of fashion, though perhaps not quite so generally as in the Elizabethan period. They covered the upper half of the face, leaving the mouth free. They continued in use down to the last century, as did also very generally among women of fashion, the custom of painting the face. But at the close of Charles's reign, just entering the Commonwealth, the ladies adopted a still more ridiculous fashion, that of covering the face with patches or spots. A popular satirist of the year 1650 tells us that "Our ladies have lately entertained a vaine custom of spotting their faces, after the affectation of a mole, to set off their beauty, such as Venus had." But they were not content with this simple molecular form, but the patches were cut into suns, and moons, and stars, and a variety of other shapes. One lady is represented with a patch on her forehead representing a coach and four horses. But great periods of transition, as this was, are usually marked by excess in outward fashions. Such was the case in the beginning of feudalism, and so it was when feudalism passed into another state of things. Absurd, stiff, and exaggerated as the costume of the sixteenth century—that is, the period which followed the breaking-up and extinction of feudalism—may appear to us, it is in it that we shall find all the elements of the various forms of modern dress.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LAT. 51° 28′ 6″ N. LONG. 0° 18′ 47″ W.

BY G. M. WHIPPLE.

(BY PERMISSION OF THE METEOROLOGICAL COMMITTEE.)

(With a Plate.)

APRIL, 1869.

ATMOSPHERIC PRESSURE.—During the first two days in the month the barometer steadily descended, reducing the daily means from 29·913 ins. on the 1st to 29·425 ins. on the 3rd. At 2.50 A.M. on the latter day a sudden elevation of 0·036 ins. was registered. The next day, the 4th, a uniform rise was maintained, which brought the mean for the 5th to 30·119 ins. After this there were only minor variations in the pressure until the 12th, when an increase occurred, which gave 30·238 ins. as the mean for that day. The same height was kept up on the 13th; but on the 14th, a rapid fall occurred, which ceased at 4 P.M. Another fall, commenced at 2 P.M. on the 15th, and continued to 2.45 P.M. on the 16th, reduced the means to the minimum of the month, 29·178 ins.

The barometer oscillated for some time about this point of low pressure; but afterwards rose steadily through the 17th and 18th, raising the readings to 30·090 ins. on the 19th. A little diminution of pressure on the 20th, was followed by a gradual upward movement, which culminated at 30·246 ins. on the 29th, the highest mean of the month.

The mean pressure for April was 29·960 ins.

TEMPERATURE OF THE AIR.—Independently of the gradual change which slightly raised the means from 37·9° on the 1st to 41·8° on the 3rd, the thermometric records give nothing remarkable until 6 A.M. of the 5th. The temperature then rose very rapidly, at 9 A.M. it again became constant; but another rising movement commenced at noon on the 6th, and continued at a uniform rate until midnight. This made 52·4° the mean for the 7th. On the 9th, the mean temperature was a little lower, and the thermometer stationary from 6 P.M. until 6 the next morning; but during the night of the 10th there was considerable fluctuation, and a rapid rise during the early hours of the 11th. The highest mean of the month, 60·0°, as well as the maximum temperature, was attained on the 14th; but the means follow a descending curve the succeeding days to 45·4° on

the 18th, after which date they regularly increased to 58·2° on the 28th.

The instrumental traces show much fluctuation on the 21st and 22nd; but from 5 P.M. of the 23rd to 6 A.M. of the 24th they were unusually free from variation.

There was the ordinary daily fall of temperature in the register of the 26th, until 8.15 P.M.; the thermometer then rose until 12.40 P.M.; afterwards falling quickly, it regained its normal position at 2 A.M. A reduction in the means on the 29th and 30th, gave for the latter day 48·1°.

The highest temperatures recorded by the maximum thermometer in April were 75·2° on the 11th, and 75·3° on the 14th; the lowest given by the same instrument were 47·5° on the 3rd, and 48·1° on the 9th.

The lowest points reached by the minimum were 28·4° on the 2nd, and 32·5° on the 5th, its highest reading was 52·9° on the 15th.

The daily range had its greatest extent on the 11th, 33·8°; and its least, 3·7°, on the 9th; the mean for the month being 17·6°.

The mean temperature for April was 49·9°.

RELATIVE HUMIDITY.—This stood highest on the 8th and 23rd, when it was 0·92 and 0·98 respectively; and lowest on the 28th, 0·60; the mean for the month being 0·78.

Complete saturation is represented by 1·00.

RAINFALL.—The Rain measured was as follows:—

DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.
3.....	0·048 inch.	15.....	0·018 inch.	19.....	0·010 inch.
4.....	0·035 „	16.....	0·014 „	21.....	0·015 „
7.....	0·225 „	17.....	0·250 „	24.....	0·570 „
8.....	0·010 „	18.....	0·070 „		

The total fall during April being 1·265 ins.

WIND.—The general direction of the wind was:—

North—4th, 18th, 23rd.
North-East—1st, 9th, 11th, 27th, 28th, 29th, 30th.
East—8th, 10th, 14th, 26th.
South—6th, 12th, 15th, 19th, 20th, 22nd.
South-West—2nd, 3rd, 7th, 13th, 16th.
West—5th, 21st.
North-West—17th, 24th, 25th.

The principal features of the anemograph records for April are the following:—

A change in the direction from N.N.E. to S.W. occurred at 7.50 A.M. on the 2nd. Between 4.30 and 6.30 P.M., on the 3rd, it veered from S.S.W. to W. and N. A gradual return from N. to S.W. took place during the night of the 4th.

From 2 to 11 A.M. on the 8th the hourly velocity of the wind was only one mile, it afterwards increased to 6 miles, the direction at the same time shifting round from S.W. through W. and N. to E.

On the 14th the wind made a semi-revolution from N.E. through S. to S.W., between 11.30 A.M. and 8 P.M; a velocity of about 15 miles per hour being maintained throughout. A further change from S.W. to N.W. was registered during the night of the 16th, the mean velocity at the time being 20 miles.

The rate of motion fell to 3 miles per hour, between 1 and 10 A.M. of the 19th, and during this interval the direction veered from N. through W. to S.

At 1 A.M. on the 23rd an abrupt variation from S. to W. occurred, and at 8.15 A.M., the same day, another change, W. to N., was recorded. During the night of the 25th, there was a gradual veering from N.W. to E. The greatest amount of wind registered as having passed in 24 hours was 492 miles, on the 16th; the least, 92 miles, on the 23rd.

MAY.

ATMOSPHERIC PRESSURE.—The barometer, which had been high sometime, remained above 30 ins. until the 3rd, on which day a fall set in at noon, which lasted to midnight, this was succeeded by a period of oscillation, which resolved itself, at 6 A.M. of the 4th, into a steady upward movement. In the morning of the 5th a rapid fall, accompanied by much fluctuation of the mercurial column, commenced; but during the 6th this gradually ceased, and at 2 P.M. the barometer was stationary.

The effect was a reduction in the daily means, from 29·890 ins. on the 4th, to 29·178 ins. on the 6th.

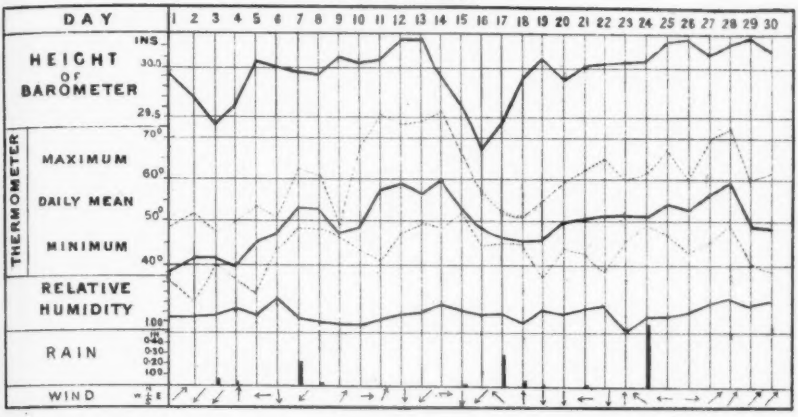
No variation took place on the 7th, but a sudden upward start happened at 4.10 A.M. of the 8th, which was followed at 10 A.M. by a gradual rise, this was sustained until 8 A.M. the next day.

From the 10th the increase in the readings was regular until the 13th, on which day the highest mean of the month, 30·203 ins., was registered.

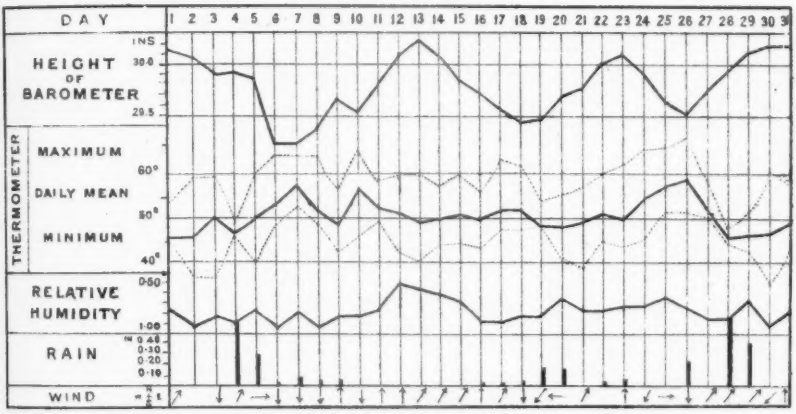
A uniform diminution of pressure lasted until 3.30 A.M. of the

DIAGRAMS, REPRESENTING THE METEOROLOGICAL VARIATIONS OBSERVED AT THE KEW OBSERVATORY.

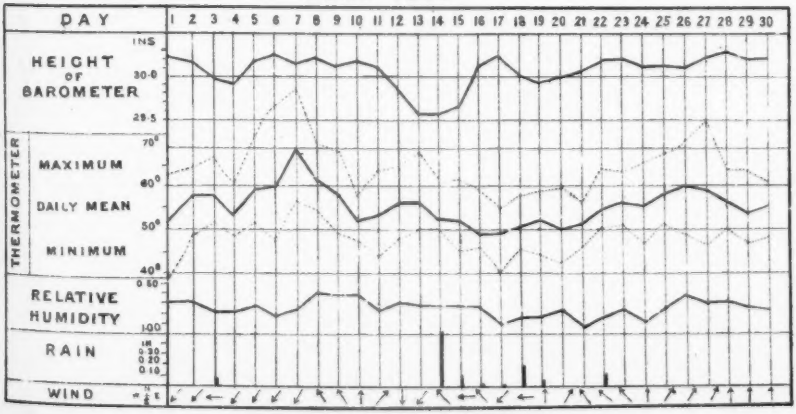
APRIL 1869.



MAY 1869



JUNE 1869



19th, when an elevation of 0·025 ins. was recorded; a similar increase of 0·030 ins. at 9.40 A.M. inaugurated a series of oscillations, which terminated at 2 P.M. in a rapid ascending movement, continued to midnight.

A slower increase of pressure brought the means to 30·078 ins. on the 23rd, after which they declined to 29·538 ins. on the 26th, but again rose to 30·129 ins. on the 29th.

The barograph showed a slight undulatory motion from 7.30 to 11 P.M. on the 28th.

The mean height for May was 29·795 ins.

TEMPERATURE OF THE AIR.—There was much less variation in the thermometer in May than in the preceding month, and the temperature was generally lower than usual at that period.

The mean on the 1st was 44·5°, but had risen to 50·5° on the 3rd. The 4th was characterised by the absence of variation of the thermometer from 3 A.M. to 8 P.M. The mean temperature rose to 56·8° on the 7th, declined to 47·4° on the 9th, but again increased to 56·8° on the 10th. Very little change occurred then until the 18th, on which day a rapid rise of 5° was registered at 3 P.M., followed at 3.15 by a sudden fall of 9°. An increase of 6° in the next half hour returned the curve to its ordinary position. On the 19th curve there are two depressions of the same kind, one of 10°, between 12.20 P.M. and 1.0 P.M.; the other of 5°, from 1.50 to 2.15 P.M.

From 48·2° on the 20th, the means gradually went up to 58·4° on the 26th, which was the highest in the month, but they diminished after to 44·4° on the 28th, rising again to 49·7° on the 31st; on the latter day a sudden lowering of temperature, 15°, took place at 10.50 A.M.

The greatest maximum in May was 69·8° on the 26th, the least 46·4° on the 4th.

The lowest minima were 35·5° on the 3rd, and 34·6° on the 30th, the highest 52·5° on the 7th, and 52·1° on the 26th.

The extreme daily ranges were as follows:—22·0° on the 2nd, 25·7° on the 30th, and 2·3° on the 4th, and 3·2° on the 28th, the mean being 14·6°.

The mean temperature for May was 50·5.

RELATIVE HUMIDITY.—The proportion of aqueous vapour in the air stood highest at 0·95 on the 6th, and 0·93 on the 8th, the lowest degrees were 0·57 and 0·62 on the 12th and 13th. The mean for the month of was 0·79 (saturation being 1·00).

RAINFALL.—The days on which rain was measured were :—

DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.
4...	0·640 inch.	9...	0·054 inch.	19...	0·163 inch.	26...	0·180 inch.
5...	0·240 „	10...	0·342 „	20...	0·169 „	28...	0·640 „
6...	0·020 „	16...	0·013 „	22...	0·025 „	29...	0·350 „
7...	0·070 „	17...	0·010 „	23...	0·040 „		
8...	0·036 „	18...	0·017 „	25...	0·005 „		

The total fall in May being 3·014 inches.

WIND.—The general direction of the wind was:—

North—9th, 11th, 12th, 16th, 23rd, 31st.

North-East—1st, 4th, 13th, 14th, 15th, 17th, 21st, 27th, 28th, 29th.

East—5th, 25th.

South—3rd, 6th, 7th, 8th, 10th, 18th, 24th, 26th.

South-West—19th, 30th.

West—20th.

During the 2nd the vane made a complete circuit by changing at 4.20 A.M. from E. to S.W., at 12.50 P.M. from S.W. to N., and at 4.30 P.M. from N. to E. The mean velocity of the wind through the day was five miles per hour. On the 6th, between 10 A.M. and 4.30 P.M., there was a shifting of the direction from N.E. through E. to S.W.

A southerly wind, which blew at the rate of twenty miles during the 8th, gave way to a calm at 10 P.M., this was followed suddenly at 11.45 P.M. by a breeze of twelve miles from the N.; this almost ceased at 10 A.M. on the 9th, and by several small changes the direction again became S. On the 11th a sudden variation from S.W. to W. occurred at 6.30 A.M. Between 8 and 11 A.M. on the 17th the direction gradually veered from W. through E. to S. Very light winds prevailed during the 22nd, 23rd, and 24th, and numerous changes took place in the position of the vane. A calm on the 26th from 8 to 9.10 P.M. was preceded by a southerly, and followed by a northerly wind.

The greatest passage of wind in twenty-four hours, recorded by the anemograph, was 631 miles, on the 14th; the least, 83 miles on the 22nd.

JUNE.

ATMOSPHERIC PRESSURE.—After the 1st there was a gradual fall

in the readings until the 4th, 30·236 ins. being the mean for the former, and 29·942 ins. for the latter days.

Those following exhibit a rise in the curve, and 30·259 ins. on the 6th, was the highest mean attained during June.

Very little variation ensued until the 12th and 13th, when a steady fall brought the readings down to 29·552 ins., the lowest in the month.

On the 14th there was much oscillation of the mercurial column about 2 A.M., and at 6.15 A.M. a sudden rise of 0·037 ins. was registered. Another series of oscillations continued to 8 A.M., and then a regular upward movement set in, which lasted, with a few slight intermissions, until 10 P.M. on the 17th, for which day the mean was 30·239 ins. There was a little movement in the opposite direction on the 18th and 19th, but afterwards the barometer remained high, and varied but little until the end of the month, 30·214 ins. being the reading for the 30th.

The mean height for June was 30·065 ins.

TEMPERATURE OF THE AIR.—This rose from 51·4° on the 1st, to 57·5° on the 3rd, and afterwards from 53·4° on the 4th, to 69·3° on the 7th, the latter being the highest point the mean temperature reached during the month. It afterwards declined rapidly to 52·0° on the 10th. The 11th read the same; but the mean for the 12th and 13th were a little higher.

The thermograph curve for the 15th was very irregular, several sudden variations from 3° to 5° in extent being recorded, and during the night there was a very unusual dissimilarity between the dry and wet bulb traces.

The mean for the 17th was 48·0°, the lowest of the month.

The temperature was also low on the 21st; and here we would call attention to a comparison made between the 20th and 21st of June and the 21st and 22nd of December last, in confirmation of a remark which appeared in some of the newspapers at the time as to the singular fact that the temperature was the same on the longest, as it had been on the shortest day of the year.

		Mean Temperature.	Maximum.	Minimum.
1868.	Dec. 21 . .	49·8°	55·2°	40·6
	„ 22 . .	48·2	53·1	46·5
1869.	June 20 . .	49·8	59·3	42·4
	„ 21 . .	50·0	56·5	46·1

After the 21st a small increase took place in the daily means,

until 58·9° was attained on the 26th; a diminution then occurred to 53·4° on the 29th.

The highest point registered by the maximum thermometer in June was 83·7° on the 7th, 79·7° being that on the 6th; the lowest maxima were 55·2° on the 17th, and 56·5 on the 21st.

The lowest readings of the minimum were 38·0° on the 1st, and 40·1° on the 17th, the highest being 55·3° on the 7th.

The largest daily range was 32·4° on the 6th, the least 10·4° on the 21st, and the mean 17·8°.

The mean temperature for June was 54·9°.

Relative Humidity.—The extremes of this were as follows:—Highest point of saturation of the air, 0·96° on the 17th, and the lowest 0·62° on the 8th, and 0·63° on the 9th; the mean for the month being 0·74°.

Rainfall.—The rain measured was:—

DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.
1.....	0·050 inch.	15.....	0·110 inch.	18.....	0·195 inch.
3.....	0·070 „	16.....	0·020 „	19.....	0·028 „
14.....	0·530 „	17.....	0·005 „	22.....	0·080 „

Total fall in June, 1·088 inches.

Wind.—The general direction was:—

North—10th, 19th, 24th, 28th, 29th, 30th.

North-East—11th, 20th, 25th, 26th, 27th.

South—12th.

South-West—1st, 2nd, 4th, 5th, 6th, 7th, 13th, 17th.

West—3rd, 15th, 18th.

North-West—8th, 9th, 14th, 16th, 21st, 22nd, 23rd.

The chief changes recorded by the anemograph were:—

On the 1st, at 8.40 A.M., the direction suddenly shifted from N.E. though N. and W. to S.W., the velocity remaining unaltered. Much fluctuation between S.W. and N.W. was registered during the 3rd. At 7.30 A.M. on the 8th, the direction changed from S.W. to N., at which point it remained until 6 P.M.; between that and 10 P.M. a veering N. to E. took place.

The next morning there was a calm from 4.15 to 5.30 A.M., and afterwards, at 6.10 A.M., there was a further change, E. to S.; another from S. to W. at 7.25 A.M. completed the circuit. The

curve for the 9th shows frequent oscillations between W. and N. On the 11th there was a movement from N. to E. at 5.40 P.M., and again from E. to S. at midnight. Another change to S.W. occurred at 5.40 A.M. of the 12th.

About 4 A.M. of the 14th there was a veering from S.W. through W. and N. to N.E., succeeded at 6.5 A.M. by a retrograde movement from N. to N.W., at which point the wind continued until 6 P.M. Afterwards there were several changes from N.W. to S., and back to W.

Through the 18th there was a veering from S.W. through W. to N., and on the 24th, at 3.50 A.M., a return from W. through W. to S.W.

The highest mileage of the anemograph in 24 hours was 444, on the 15th; the lowest, 73, on the 22nd.

ASTRONOMICAL NOTES FOR AUGUST.

BY W. T. LYNN, B.A., F.R.A.S.,

Of the Royal Observatory, Greenwich.

Of the large planets, Jupiter and Saturn only are this month in positions favourable for observation.

Jupiter rises on the first day at 10h. 42m., and on the last day at 9h. 0m. His right ascension increases during the month from 3h. 6m. to 3h. 15m., and his north polar distance diminishes from 73° 43′ to 73° 12′, so that he is near the boundary of the constellations Aries and Taurus. On the evening of the 28th he is near the Moon. The following is a list of those phenomena of his satellites which will be visible before midnight:—

DATE.	SATELLITE.	PHENOMENON.	MEAN TIME.
			h. m.
August 8.....	II.....	Eclipse, reappearance.....	11 39
„ 14.....	I.....	Transit, egress.....	11 23
„ 17.....	II.....	Transit, egress.....	11 18
„ 21.....	I.....	Transit, ingress	11 4
„ 24.....	II.....	Transit, ingress	11 33

The second satellite will reappear, after its eclipse on August 8, very close to Jupiter, on the left hand side as seen in an inverting telescope. The third satellite will be at the time on the same side, but a considerable distance from the planet; the first and fourth satellites will be on the other side, the latter about four times as far from Jupiter as the former.

SATURN sets at the beginning of the month about midnight, and, at the end of it, at a few minutes past ten. On the first day, his place is R.A. 16h. 37m., N.P.D. 110° 29′; on the last day, R.A. 16h. 38m., N.P.D. 110° 37′. He is therefore near the boundary of the constellations Scorpio and Ophiuchus; and will be near the Moon on the 15th.

THE MOON.—New Moon occurs at 10h. 8m. p.m. on the 7th day; First Quarter at 19 minutes before 1 on the afternoon of the 14th; Full Moon at 4h. 24m. on the morning of the 22nd. The bright star Aldebaran will be occulted a little after midnight on the 2nd, the disappearance taking place at 12h. 22m., but the Moon will be so low in the heavens, having indeed only just risen, that it will scarcely be possible to make an observation. The only other occultation which we need call attention to for this month is that of ξ^1 Libræ, a star of the 6th magnitude, on the night of the 13th. The disappearance takes place at 9h. 42m., the reappearance at 10h. 13m; the distances from the Moon's highest point being 169° and 130° to the right hand and to the left hand sides respectively as seen in an inverting telescope.

THE AUGUST METEORS, or *Perseides*, may be looked for about the 9th and 10th. The Moon being only a little past conjunction will not interfere this year with their visibility.

TOTAL SOLAR ECLIPSES: THE CORONA.—It will be remembered that in Major Tennant's account of the observations of the Indian Solar Eclipse, last August, he stated that the corona or "glory" which appears at the time of totality to surround the Sun, gave strongly polarized light, and that when it was examined with the spectroscope the spectrum was continuous. Of course both these observations point to the conclusion that the light of the corona is ordinary reflected solar light. At the meeting of the Royal Astronomical Society, last April, some discussion took place upon this subject, which it may be desirable to refer to, particularly as this month may give astronomers the means of obtaining some further information about it. The discussion was led to by the interest which was taken in the oral description, with which the Society was favoured by the talented Dr. Weiss, who had charge of the Austrian

expedition, and a short report of whose account was given in Vol. ii. pp. 272-4 of THE STUDENT. He stated that particular attention was paid to the spectrum of the corona, and that it was found to be pale but perfectly distinct, and decidedly continuous without any lines. Mr. De La Rue and Mr. Lockyer, expressed the surprise they had felt at this result, and Mr. Huggins remarked that when he first heard that the corona gave a continuous spectrum, he understood it to mean that this spectrum did not differ materially from the ordinary solar spectrum, but he now found that it was destitute of the dark Fraunhofer lines. He wished to know whether it was possible that the dark lines were merely not visible from the feebleness of light of the whole spectrum. Dr. Weiss replied that the paleness was not sufficiently great to lead to such an idea, and suggested that the corona might consist of two parts—reflected light, which would account for the polarization, and light proceeding from some self-luminous gas, and that the dark lines of the former co-existing with the bright lines of the latter, might mutually neutralize each other. Mr. Huggins said that there was much difficulty in accepting the existence of self-luminous gas beyond the hydrogen, of which it had been proved that the prominences were formed, and which must probably be the extreme boundary of the gases. We cannot, however, here refrain from remarking on the possibility of there being other gaseous matter of greater tenuity than hydrogen, in the highest regions of the Sun's atmosphere.

Mr. Lockyer here stated that he and several other persons, including M. Faye, had been led, by a comparison of several observations of solar eclipses (particularly that of 1851), to the belief that the appearance of the corona depended very much on the locality at which it was observed, and that it was probably in fact a phenomenon produced by the Earth's atmosphere. The Astronomer Royal, Mr. Airy, who was present, expressed his own concurrence with this view, which he had indeed formed from his own observations of several total eclipses.

Considerable interest will, we believe, be felt in some remarks made by Mr. Baxendell of Manchester in a letter to Mr. Huggins, which was printed in the "Monthly Notices" of the Society for last May,* being suggested by the account of the above discussion.† "Recent observations and discoveries," he says, "indicate very

* Vol. xxix. p. 293.

† A very good account of the discussion is contained in the May number of the "Astronomical Register," p. 101.

clearly that the corona is not an appendage of the Sun. What then is it? or how is its appearance to be accounted for? In a conversation I had some weeks ago with Professor Roscoe on the subject, I reminded him that in a paper which I read to the Literary and Philosophical Society in March, 1864, giving the results of a discussion of an immense number of magnetical and temperature observations made in different parts of the world, I showed that these results could be best explained by assuming the existence of an irregular nebulous ring circulating about the Sun, nearly in the plane of the ecliptic, and at a mean distance of 0·169; and I suggested to him that the reflection of the Sun's light from the matter of this ring might be the real cause of the appearance of the corona in total solar eclipses. The view taken by M. Faye and the Astronomer Royal appears to me to be quite inadmissible. During that portion of the time of totality when the corona is seen to the greatest advantage, no part of the Earth's atmosphere within a considerable angular distance of the Sun and Moon receives any direct sunlight, and therefore none can be reflected from it. Nor can I conceive how the corona can be due to any atmosphere about the Moon that could not be detected under other circumstances than those of a total solar eclipse. The differences in the appearances of the corona as seen and described by different observers, cannot fairly be adduced as an argument against its cosmical origin; on the contrary, they are precisely what might be expected to occur with such an object seen under slightly different conditions of transparency of the atmosphere, and with eyes of different degrees of susceptibility to faint impressions of light. Further investigations, which I have made since I communicated the paper referred to above, to the Literary and Philosophical Society, have yielded no results that at all militate against the conclusions at which I have arrived."

It is, we think, evident that an additional conclusion may also be arrived at, which is, that it is very desirable to obtain further careful observations of the spectrum of the corona when opportunity shall be afforded. Our American cousins will have such a one on the 7th of the present month of August, on the afternoon of which day a total solar eclipse will be visible in several of the States of the Union. Although the astronomers of that country are well able to look after such phenomena, yet it is gratifying to have reason to believe that British science will not be unrepresented on the occasion, which we may hope will again lead to some extension of our knowledge of solar physics. The line of centrality of

the eclipse runs from north-eastern Asia across what was Russian America, in a south-easterly direction through the states of Iowa, Illinois, Indiana, Kentucky, and North Carolina, the time of totality in the United States being about 5 o'clock in the evening, and its duration varying from 2 minutes in North Carolina, to upwards of 3 minutes in Iowa.

It may here be also mentioned that Major Tennant, to whom we owe so much in the organization of the expeditions sent to the East Indies to observe the total eclipse of last year, is already making suggestions as to the advantages which may probably be derived from observing as completely as possible (particularly with reference to the spectrum of the corona) the eclipse which will be total in the same part of the world in December, 1871. Astronomical activity has of late years been so greatly on the increase that it may well be hoped that expeditions will really be set on foot for this purpose.

VARIABLE STARS.—The known variable stars which arrive this month at a maximum of magnitude are, in order of length of period, S Vulpeculæ, R Virginis, T Piscium, S Ursæ Majoris, S Ophiuchi, T Virginis, and R Pegasi. All, except those in Virgo, may be observed in the evening, and we give a table of their places, periods, and probable dates of greatest brightness. T Piscium and R Pegasi do not rise until somewhat late.

NAME OF STAR.	R.A.	N.P.D.	PERIOD. DAYS.	MAGNITUDE WHEN		DAY OF MAX.
	h. m. s.	° ′		MAX.	MIN.	
S Vulpeculæ	19 43 2	63 2	68	8·7	9·5	Aug. 25
T Piscium	0 25 13	76 7	147	9·5	11·0	„ 19
S Ursæ Majoris	12 38 13	28 11	225	7·8	10·9	„ 26
S Ophiuchi	16 26 43	106 53	234	9·0	12·5	„ 26
R Pegasi	23 0 4	80 10	380	7·0	11·0	„ 20

ON THE USE OF COCA.

(ERYTHROXYLON COCA, LAM.)

BY JOHN R. JACKSON, A.L.S.,

Curator of the Museum, Royal Gardens, Kew.

THE common habit amongst the natives over large tracts of country in South America of chewing the leaves of the coca plant (*Erythroxylon coca*), and of the great antiquity of that custom—it having originated with the Incas—is probably pretty well known. Most of us, also, have no doubt read accounts by South American travellers which appear almost fabulous, how that the natives will exist for three or four days entirely without food, and perform all their accustomed duties, if they have only a few coca leaves and a little lime to chew. We have it on the most reliable authority from modern travellers, that an Indian, with a chew of coca leaves in his mouth, will work hard for two or three days together without food, and without feeling the least desire for sleep. Coca forms a regular article of commerce among the Indians; there is scarcely a man, be his occupation whatever it may, but uses it more or less. They carry the dried leaves in a bag, and the powdered lime, with which they are chewed, in a small gourd. The plant producing these leaves is a shrub, usually six or eight feet high, bearing little clusters of small white flowers, which appear after the leaves have fallen away. The leaves themselves are thin, oval, dark green on the upper surface, and paler on the under, with two distinct marginal veins running along the edges.

The following notes on the use and effects of coca, from a private letter, the writer of which is located in Lima, may not be without interest. The plants grow wild beyond the Cordilleras, but are also largely cultivated in the valleys there, which must be from 7,000 to 10,000 feet above the level of the sea. In favourable situations they grow to a height of ten feet. The ground is warm, and the rains are abundant. The seed is usually sown with maize, which protects the young plants from the powerful rays of the sun. This protection is needed for the first two years. When the leaves are fully grown, they are gathered, and well dried in the sun for preservation, and if there were any statistics of internal commerce the value of this plant would figure as no inconsiderable item. There is little or no exaggeration in the accounts given of this plant by travellers. The Indians appear to have held it in reverence for

centuries as a gift from heaven, and, to this day, they put a few leaves in the mouths of their dead. It is very certain that the leaf has the power of sustaining life, and even vigour, for a very long time. Hard indeed is the life of these poor Indians. The length of their journies is almost incredible, and yet they undertake them frequently without any other provision than a small store of these leaves. Every Indian on the march carries a little bag of them, and occasionally he pulls out a few, sprinkles them with a little pulverised lime, chews them, swallowing the saliva, and rejecting the chewed leaf. Sometimes sugar and other substances are used, but lime causes the juice of the leaf to flow more freely. A decoction of this leaf, a little warm water poured on some of them in a cup, is reputed to have often preserved sick people who could not be made to take nourishment. The opposite effects it has on different constitutions is, perhaps, due to its being too strong a stimulant for people of inactive habits, but there is satisfactory proof that it is beneficial to the poor Indians, whose lives are one long chapter of unparalleled hardships; nor does it appear to be prejudicial to them in any way, for they are well known to be a long-lived and healthy race. Referring to a native minister who had gone into the interior, the writer of the letter says that he confirmed all that travellers have told us about the extraordinary properties of the plant, such, for instance, as its power of strengthening the system, or even sustaining life, and suggests that it would be a most valuable addition to the stores of an army on campaign, and that he often thought of sending some to the Crimea during the war with Russia. He further expresses surprise, that when the British government sent Mr. C. R. Markham to obtain the cinchona plants for transmission to India, the coca was overlooked, and he thinks it would be a positive blessing to humanity to introduce it into India.

When taken in excess, coca produces a feeling of intoxication somewhat similar to that produced by opium, but, perhaps, scarcely so violent. When used in moderation, however, it produces a pleasurable influence on the imagination, a feeling of lightness, and freedom from care. At the present time the use of coca prevails throughout the greater part of Peru, Quito, and New Grenada, as well as along the banks of the Rio Negro.

FLOWERS OF THE GRASSES.

BY M. BIDARD.

(From "Comptes Rendus," No. 25, 1869.)

THE flower of the Graminaceæ is formed of a perigone or glume with two valves. The outer valve, which is always the largest, is disposed in the form of a keel (*carène*). Its texture is rough and parchmenty. It envelopes the internal valve. The interior valve is almost flat on its external surface, its tissue is thin and transparent. It is folded inwardly at its margin, so as to form two curtains closed at the upper part, and separated at the bottom, and it is beset with numerous hairs on its sides. The arrangement of these two valves makes them form a closed compartment by their juxtaposition, which is shut all the more effectually through the existence of the hairs on the inner surface. In this compartment lie the organs of fecundation and the ovary.

The stamens are three in number, and their size is such that they occupy two-thirds of the chamber formed by the valves. One stamen is placed on each side of the ovary, and one in front of it. The filaments do not exceed the length of the ovary, and at the base of the ovary, in all the grasses, are two glands, *glumellæ* of botanists, varying in shape according to the species.

The ovary is surmounted by two stigmata, and each stigma forms a principal canal from which smaller canals branch laterally, carrying thread-like tubes open at their extremities.

The phenomena of fecundation appear as soon as the floral organs have acquired their full development. With the grasses the fecundation is instantaneous, and exhibits the following characters: The anthers open laterally; they are animated by a moment of torsion; they let a shower of pollen fall upon the fan-shaped stigma. At this moment the filaments elongate themselves rapidly, and this action, coupled with a movement of torsion, opens the valves, and allows the flower to hang out. At this moment the cultivator says, "the corn is in flower"—it is an error, the fecundation has terminated. The filaments of the stamens are not disposed in a frill or doubled back upon themselves. To permit of their elongation, a specially prepared matter is required, and this they obtain from the two glands at the base of the ovary. These glands contain a thick juice which can be extracted by pricking them with a needle. These glands serve the alimentation of the filaments so well that they empty themselves when the elongation takes place.

The pollen of the grasses does not exhibit any trace of pollen tubes, and in no case have I been able to observe any ejection of fovilla. When the pollen falls on the stigma it attaches itself to the thread-like tubes which perforate it. These tubes open at their ends, act as suckers, which pump up the fovilla in order to transmit it through the canals to the ovary. After fecundation the perforated pollen dries up, while the stigma folds back upon itself and withers.

Thus there exist in the grasses two principal phenomena, which we only know as belonging to this family—

1. The elongation of the filaments of the stamens and their expulsion. 2. Fecundation by perforation of the pollen. There is a sufficient reason for these acts. The grain resulting from fecundation is destined to occupy after its full development the whole of the compartment formed by the reunion of the two valves. Now, as the stamens occupy two-thirds of this space, and would by their volume hinder the growth of the grain, they must be expelled; and for that purpose we have the elongation of the filaments, and the existence and action of the alimentary glands. As the fecundation is instantaneous, it is necessary for the fovilla to penetrate the ovary instantaneously through the stigma, which only exists up to that time. Hence the structure of the stigma, and the perforation of the pollen.

All the facts I have indicated may be observed very easily in all the cereals or in meadow grasses. To view the details of the fecundation it is sufficient to make a longitudinal slit in the external valve, when on separating the two portions, the organs of fecundation are seen between the two curtains of the internal valve. The heat of the breath, or a ray of sunshine is sufficient to bring about the phenomena of fecundation.

The natural hybridization of the grasses is impossible owing to the exact closure of the chamber containing the fecundating organs.

READE'S DIATOM PRISM.

In our last number mention was made in Mr. Slack's paper of a mode of exhibiting diatoms recently brought before the Royal Microscopical Society by its president, the Rev. J. B. Reade, and which he considers to produce so excellent an effect as to finally settle the question of the structure of the diatom valves. Making some allowance for an inventor's partiality, we may admit the importance of the method devised by Mr. Reade, but good microscopists have long been in the habit of showing diatom markings as resulting from aggregations of silicious spherules, and the new plan makes no fresh revelations of structure, it only confirms what we knew before, and does so in a valuable way.

Prisms have been long in use for illuminating microscopical objects, but no one seems to have used them in the simple and successful way employed by Mr. Reade. Dujardin substituted a prism for the substage mirror, and recommended it, as stated by Quekett, in his work on the microscope, for use with an achromatic condenser. In this case the prism differs in action from the plane mirror, in having only one surface of reflexion instead of two; the mirror, as is well known, reflecting light first from its glass surface, and secondly from the silvered surface behind the former, and thus in some cases introducing a little optical confusion.

The Abraham prism is accurately described by Dr. Carpenter as taking the place of the concave mirror—it condenses as well as reflects from a simple surface.

Prisms have often been used for oblique illumination. Thus Nachet's eccentric prism and Amici's prism were both intended for this purpose—the former giving an obliquity stated by Carpenter to be about 40°, and the latter affording any amount of obliquity the thickness of the stage will permit. These prisms refract as well as reflect, and cause converging rays to strike upon the object.

The peculiarity of Mr. Reade's system is that he employs his equilateral prism to throw parallel rays with a small obliquity, and obtains effects on diatoms for which great obliquity has usually been thought indispensable. The prism is held, according to the construction of the microscope, by some arm or substage, which keeps it in the position of a chord or diameter of the stage aperture. Mr. Reade says:—"At present I fix the prism on the substage with an india-rubber band. All that is required is the power of turning the prism on its axis, and also of placing it over any diameter, or any chord of the substage. In the latter position the prism,

lying over a chord from 30° east of the vertex of the stage to 30° west of south, and its face slightly inclined to the upper stage, very effective obliquity is obtained. The lamp of course stands to the west. We must rotate the valve by the circular motion of the upper stage till the hemispheres are not obscured by the parallel lines of their own shadows. When they reach their proper place, they seem to start into existence, and the degree of elevation is conferred *per saltum*."

Mr. Highley has been first in the field as the mounter of prisms on Mr. Reade's plan, and we have no doubt other opticians will soon follow him. We are glad to see he supplies this apparatus at a very moderate price.

With regard to the accuracy of indications obtained in this way, we need only remark that the more the microscopist can imitate natural conditions of vision, the more he is likely to escape bewilderment and error. Natural objects are seen as the sun, or diffused light illuminates them with parallel rays, and we rarely observe them with any considerable obliquity of either reflected or transmitted light. The Reade Prism approximates to natural conditions, and we do not see that it can introduce any source of mystification. The action of the substance of a diatom valve upon the light which it supplies is curious. When everything is properly arranged, the dots look like "a plate of marbles," as a juvenile judiciously observed. They seem solid, and the eye might fancy they were seen by reflected light.

We do not think the Reade Prism will be a general substitute for other modes of illumination, but it should be extensively tried. It throws shadows in one direction only, as sun-light does; and, though multilateral illumination may sometimes possess advantages, it cannot be denied that it may permit errors of interpretation to creep in to an extent not probable when unilateral illumination with parallel rays is employed.

ARCHÆOLOGIA.

Mr. Roach Smith, in the third volume of his "Collectanea Antiqua," Plate XXXII., and in his sixth volume, Plates XVI. and XVII., has published engravings of Roman leaden seals, of a very remarkable description, from Brough-upon-Stanmore, in Westmoreland, where these seals have been found in large quantities. Mr. Smith considered them, as their appearance would lead us to suppose, to have been fastened to merchandise of some kind by strings, which passed through the centre, in the same manner as the leaden seals or *bullæ* were affixed to the Papal deeds. In a recent "Bulletin of the Commissions Royales d'Art et d'Archéologie" of Belgium, M. H. Schuermans, one of the most active members of the commissions, has printed a rather elaborate paper on Roman inscriptions relating to traces of Belgians discovered in foreign countries in the Roman period. Among these are several monuments of the Nervii, Tungri, and other Belgic auxiliaries in Britain, which he naturally includes in his collection, and he has had the leaden seals alluded to re-engraved from Mr. Roach Smith's plates. One or two of them are inscribed C II NER, which Mr. Smith interprets as *Cohors II. Nerviorum*. Others have the inscription C VII TR, which he reads *Cohors septima Trevirorum*. M. Schuermans accepts Mr. Smith's readings; but he considers the objects themselves not to be seals, but, to use his own words, *projectiles de guerre*. He does not inform us how he thinks they were used; and this seems so difficult to conceive, that we hardly think he will gain converts to his opinion, when these objects are examined *en masse*, together with two similar seals found at Richborough, which bear the effigies and name of one of the Constantines. As just stated, they are made precisely in the same manner as the papal bulls, and as the mediæval leaden seals attached to bales of cloth; indeed, the process is still common in some trades. A cord of silk or twine is laid between two pieces of lead, which are pressed together in a mould, which has one side engraved. In the Brough examples, and in those from Richborough, the apertures on each side indicate the place of the cord. It seems impossible to consider such objects as intended for warlike purposes; but it is a question difficult to answer in our present state of knowledge, why so many of them are found at Brough (which is considered to be the Roman *Verteræ*), and not at the other Roman stations. Mr. Roach Smith conjectures that they must have been manufactured in large quantities at Brough for

merchandise, which was perhaps distributed thence, as, with the exception of the two found at Richborough, and two from Felixstowe in Suffolk, they have not been found in other stations in Britain. M. Schuermans, regarding them as missiles of war, has no doubt they abounded wherever military bodies were established, but that *they have not yet been discovered.*

The coming month will be one of ARCHÆOLOGICAL CONGRESSES. The British Archæological Society begins its meetings at St. Albans, on Monday, August 2nd, with Lord Lytton for president; the Cambrian Archæological Association, at Bridgend in Glamorganshire, on Monday, August 9th, under the Earl of Dunraven; the Kent Archæological Society, at West Malling, on Thursday, August 5th; and the British Association, at which pre-historic Archæology is expected to make a great figure this year, at Bath, on Wednesday, the 18th, under the presidency of Professor Stokes.

A curious monument of antiquity has been discovered at Loughor, in Caermarthenshire, and is described in the new part of the "Archæologia Cambrensis." Loughor is believed to mark the site of a small Roman station, and the monument in question is a ROMAN ALTAR in stone, the original inscription or sculpture of which is no longer visible, but on one of its edges is an inscription in OGHAM CHARACTERS. This curious stone, when found, formed one of the steps leading up to the rectory house of Loughor, and it is now placed upright on the lawn in front of the rectory. Ogham characters, which are considered to be originally Irish, are not properly letters, but a system of marks to represent letters, bearing analogy to the various systems of cyphers so much in use in the later Middle Ages. They are found principally employed in monumental inscriptions of a very early period. In this instance the altar, raised to some one of his gods by a Romano-Briton of the station now represented by Loughor, has been taken by the Christian Britons of a subsequent period, though no doubt remote, and used as a monument to one of their dead. The Oghams, it appears, are not very legible, and have received some damage, but an antiquary of experience in this subject reads them, L . . . AS IC, marking the first letters as doubtful. T. W.

CORRESPONDENCE.

AN EXTRAORDINARY CUCKOO.

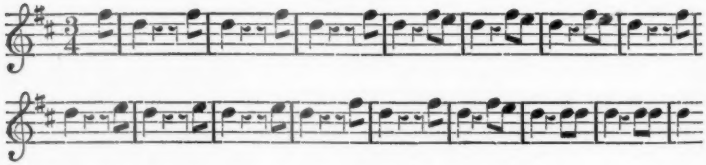
To the Editor of THE STUDENT.

SIR,—An extraordinary cuckoo, which has recently arrived here, and which I first heard, to my no little astonishment, one fine morning when I was taking a look at Jupiter. I think his notes (not Jupiter's) betray a real inventive faculty, and I don't like to let them go to waste in the desert air of Millbrook. I, therefore, should wish to see them published in THE STUDENT. I found the pitch by a tuning-fork, and have given it quite exactly, though this is a matter of secondary importance, not differing, I believe, from that of ordinary cuckoo-notes. The strain is in D major, and I have watched closely for a flat third or minor, but there is no such thing. There are always two distinct changes from the ordinary notes, and on one occasion I heard a third, which was a repetition of the key-note, as in the last bars of the following. This reminded me of a bird that I used to hear in Switzerland, and which they call *Wiederhop*—a name very descriptive of his repeated monotone.

In greatest haste, very truly yours,

J. BIRMINGHAM.

Millbrook, Tuam, June 24, 1869.

NOTES OF A CUCKOO HEARD AT MILLBROOK, TUAM, IRELAND, JUNE, 1869.

And so on, the changes running at irregular intervals.

[Mr. Birmingham's cuckoo was certainly an extraordinary one, though we heard one of these birds this summer in Ashdown Forest, Sussex, make a cry of three notes more than once. In Gardiner's "Music of Nature," the cry is given—

And in a note it is added—"The song of the cuckoos I have invariably found in Leicestershire to be in the key of D. If the cuckoos in other counties should be found to accord with this curious fact, as nature is pretty much the same, we may take these notes as a standard of pitch." White, of Selborne, observes, "I have tried all the owls of this neigh-

bourhood with a pitch pipe, and found them to hoot in B flat, and the cuckoo to sing in the key of D."

Mr. Timbs, in "Things not Generally Known," observes—"The cuckoo begins to sing early in the season with the interval of a minor third, the bird then proceeds to a major third, next to a fourth, then a fifth, after which his voice breaks without attaining a minor sixth." It is clear that these gradations are not universal, or so good an observer as Gardiner would have noted them. Mr. Sterland, in "The Birds of Sherwood Forest," says he has positive proof that the cry of the cuckoo is uttered by both sexes, and it would be interesting to know whether the male and female utter the same notes. In addition to the common cry, he states that "it has another note of a very liquid character, resembling the syllable 'quille' which I have remarked it repeat quickly five or six times in succession, and generally after it has alighted on a tree."]

DIAMOND DISCOVERY IN SOUTH AFRICA.

To the Editor of THE STUDENT.

SIR,—By the homeward mail I beg to forward you a copy of a pamphlet recently published by the Editor of the *Colesberg Advertiser*, on the diamond discovery of South Africa, in connection with certain statements and assertions on the subject made by Mr. J. R. Gregory, a gentleman sent from England during last year by Mr. H. Emanuel, for the purpose of investigating and reporting upon the discovery.

My reason for thus troubling you is, that the conclusions arrived at by Mr. Gregory appear, to such of us as are interested in the existence of diamonds in South Africa, to be as crude and unsatisfactory as his reflections on the action taken by the Cape Colonists are unfair and unjust. I need scarcely add that your opinion on the subject would be greatly valued.

With reference to the "great" diamond of 83½ carats, alluded to in the latter part of the pamphlet, I may mention that the gem has been disposed of to Messrs. Lilienfield Brothers, of Hope Town, for £11,500 sterling. This sum is believed by Mr. Hond, a practical lapidary, to be approximately one-third its market value in England.

Certain gentlemen, eight in number, resident on the northern frontier of the Colony, before the disposal of the diamond above-named, obtained a monopoly, through a cession-bond, granted by Waterboer, paramount Chief of the territories north of the Orange River, where the large diamond had been pronounced to have been found, securing to them all minerals and precious stones discovered there after the signing of the contract; the consideration to Waterboer himself being the one-fifteenth part of the nett proceeds accruing therefrom. In consequence of this compact, Mr. Justice Cole, on a recent sitting of the Circuit Court at

Colesberg, granted, on the affidavits of the gentlemen referred to, an interdict refraining Messrs. Lilienfield from a further disposal of the diamond. By last post from Cape Town, we learn that the confirmation of the edict has been refused by the Supreme Court. No doubt, therefore, the gem, estimated at present as the thirteenth in value the world has yet produced, will soon be secured to an English purchaser.

Apologising for thus intruding on your time,

I am, Sir, your obedient servant,

GEORGE GREY, M.D.,

District Surgeon to the Government, etc.

P.S.—Should you consider the remarks I have now penned to be of interest in any way to your readers, you are, of course, at liberty to use them, or my name in reference to them, if you think proper, in the columns of THE STUDENT, to which periodical I have been, to my profit, a subscriber from the date of its introduction to the scientific world (or shortly afterwards, while yet known as "Recreative Science"), to the present time. G. G.

CRADOCK, CAPE OF GOOD HOPE,
May 27th, 1869.

[After Dr. Grey's letter, and a perusal of the pamphlet to which he alludes, Mr. Harry Emanuel's and Mr. Gregory's statements cannot be accepted without an amount of proof they do not supply. The evidence, as it stands, distinctly contradicts Mr. Gregory's assertion that the district in question contains no primary rocks, and no diamondiferous formations. He accuses the colonists of fraud in their accounts of the alleged diamond discovery, and they declare that his examination was incomplete, and his statements incorrect. Diamond-dealers will know whether the large stone stated to have been sold to Messrs. Lilienfield for £11,500 is genuine and worth the money. It would be ridiculous to suppose that such a stone was sent to the Cape for purposes of fraud, and gems of that magnitude become well known throughout the trade.]

THE ILLUMINATION OF THE MOON'S SURFACE DURING A TOTAL ECLIPSE.

To the Editor of THE STUDENT.

SIR,—The question propounded by Mr. Smeaton in THE STUDENT for July, p. 460, whether, when a total eclipse of the moon happens near an equinox, we may expect its surface to be much more illuminated than when the eclipse happens near a solstice, must, it appears to me, be answered affirmatively, for the following reasons:—The sensible illumination of the moon's surface during a total eclipse can only be due to the sun's light refracted by the earth's atmosphere. The refracting power of the

atmosphere increases with its density, and there are three causes which render the air at the poles denser than anywhere else on the earth's surface. First, the extreme cold; second, the increase of gravity in consequence of the polar diameter being shorter than the equatoreal; third, the centrifugal force of the earth's rotation becoming zero at the poles. The air at the poles, therefore, has the highest refractive power, and the air of the equator the lowest refractive power; the conditions which affect density being there exactly reversed. Now, when an eclipse happens at an equinox, the plain bounding the light and dark hemispheres of our globe will pass through the poles. In this case, therefore, some of the sun's rays will pass completely through the strongly refracting atmosphere of the frigid zones, and be deflected on to the moon's surface. When an eclipse happens at a solstice, the terminating plane will touch the arctic and antarctic circles, so that the poles will be as far as possible from the edge of the illuminated hemisphere, and the refractive power of the atmosphere will be reduced to its minimum value. The air of the temperate zones will indeed have more refractive power than that of the torrid zone, but in the former the light of the sun will be very liable to be intercepted by clouds: and this may have caused the entire disappearance of the moon on the two occasions mentioned by Mr. Smeaton.—Yours obediently, S. S. GREATHEED.

Corringham Rectory, Essex.

PROGRESS OF INVENTION.

GAS BURNER.—M. J. Rousselot, of Paris, has invented a new gas-burner, the object of which is in part to do away with the flickering of the flame, so as to render the light steady, also to cause a more perfect combustion of the carbon. It consists of a metal piece having several openings, through some of which gas issues, and through the others atmospheric air, which mixes with the gas. It appears to be a modification of the principle of the ordinary Bunsen burner.

WARMING CHURCHES, ETC.—The following method seems to be simple, and to be founded on a good principle; it is patented by Mr. W. H. Smith, of Mall-place, Clifton. A brickchamber is made beneath the floor of the building, and a grating is placed over it to allow of the passage of hot air. Beneath this chamber an air flue in connection with the flooring, and covered with an iron grating, is introduced. By these means a current of air is made to pass into the building, and this air is brought into contact with a ring gas-burner, which is supplied by an ordinary main by means of a spanner, by which the amount of heat can be regulated. Underneath this ring-burner is placed a small cistern made of fire-clay, filled with water; the heat from the gas-burner acts

upon the water, steam arises, and this is passed through pumicestone contained in a cylinder above the cistern; the use of this vapour is to moisten the atmosphere contained in the reservoir. Around this is a circular cylinder made of fire-clay, to contain heat. The whole is covered with a dome of fire-clay. This dome is worked by a lever for the purpose of lighting the ring-burner. By these arrangements, it is said that a pure heat, free from smell or smoke, is obtained, and that with a very small consumption of gas.

Dental Appliances.—Mr. James Wallace, of Glasgow, has patented the use of aluminum as a substitute for other metals when used for dental purposes. His method consists essentially in joining the plates and other parts, to which artificial teeth are connected, of aluminum, the different pieces of which are fastened together by vulcanite or other metallic material. Another part of the invention consists in engraving a design on the part of the plates next the flesh of the mouth, and by which they are more securely held in place than when formed plain or smooth.

Fixing Colours on Textile Fabrics.—Solutions of iron, copper, manganese, or chromium, either pure, singly, or mixed together, or in conjunction with colouring matters, are by this process employed for printing on textile fabrics, which consist of wool and cotton, wool and thread, goats'-hair and cotton, etc., and on all other tissues composed of a mixture of textile, vegetable, and animal matters, either by means of the cylinder printing-machine or otherwise, the process being the same as that for printing thread tissues, thread and cotton, or cotton. The fabrics are allowed to oxydize after the application; the oxidation being completed by subjecting them to an alkaline or bichromate bath. The advantages of the application of this system to the tissues named, is that the colours or tints obtained are unchangeable either by the action of light or washing. The inventors are Constantine Descat, and Henry Guillaume, Boulevard Sébastopol, Paris.

Tooth-Brushes.—There has lately been introduced into the market a porous form of vulcanized india-rubber, called india-rubber sponge. It is proposed to substitute this material for bristles in the manufacture of tooth-brushes. To effect this, Messrs. P. B. Cow, and John Hill, of Cheapside, fix a piece of india-rubber sponge to a handle of bone or ivory, and they form ridges on the surface of the spongy material. Other brushes are made in a similar manner by fixing spongy-vulcanized india-rubber to a rigid back or handle; or, in some cases, as for horse-brushes, a rigid back only is required. In some cases, the spongy india-rubber is checkered or cross-grooved. This material is found to answer well for the purposes to which brushes are generally applied.

Purifying Coal-Gas.—Mr. Alexander Rollasin, of Bristol, has invented a method of purifying coal-gas from ammonia. He takes peat, or other decomposed vegetable matter, and having disintegrated it, mixes with it strong sulphuric acid, in about the proportion of one part of

the latter to two of the former, after which, he heats it slowly until it has become changed by the sulphuric acid; or after the peat or other matter has been disintegrated he dries it, but not too rapidly, and then adds the acid. A second process consists in heating clay, or other silicious matter, so as to drive off the carbonic acid contained in it, and then mixing with it sulphuric acid. Either of these mixtures can be put into the ordinary coal-gas purifiers, and the gas passing through will be deprived of its ammonia, which will, with the sulphuric acid, form sulphate of ammonia. Either of these mixtures can also be mixed with gas-liquor, which contains ammonia, and on evaporation, sulphate of ammonia will be produced.

Blinkers.—A very ingenious blinker has been invented by M. Joseph Isidore Niepce, of Givry, Saône et Loire, France. The blinker is provided with a very simple and strong mechanism, in connection with a bellows expanding cap, or obdurator, which it keeps constantly closed within the blinker, unless the driver, by pulling on a small rein attached to the mechanism, causes the obdurator to open, when it completely covers the horse's eyeball, totally depriving it of sight, and causing the horse to stop; upon abandoning the rein, the obdurator closes again, the horse recovers his sight, but the accident is avoided.

Fishing Rods.—Mr. Bashley Bittern, of Red Hill, proposes to make fishing rods of iron, steel, or German-silver, instead of pliable wood or cane. He constructs the rods as follows—either in one or several pieces, connecting them together by joints in the usual way or by any other means better adapted for the purpose. He uses either solid or tubular metal with the view to obtaining lightness and flexibility.

Cracking Nuts.—The patentees of this invention are Messrs. William E. Bates and Thomas Dodd. It is intended to be applied principally for the cracking of palm nuts, in order to remove the shell previously to submitting the kernels to the action of the press for extracting the oil, but it may also be used for the purpose of cracking any other kind of nuts that are required to be cracked in large quantities.

The invention consists in the use of a revolving fan producing a blast or current of air, and throwing the nuts with sufficient force against an iron or metal target to crack them without injuring the kernels. The pan is enclosed in a sheet of iron or other suitable case, having an entrance passage, provided with a hopper for the introduction of the nuts, and a discharge pipe through which they are driven by a current of air, and discharged against the iron target, by striking which they are broken.

Colouring Matter.—Pure manganese, or the cheap residues of compounds of manganese left from the preparation of chlorine, are mixed with phosphoric acid; heat is then applied till liquefaction takes place. After cooling, the manganese is precipitated by ammonia or by carbonate of ammonia, and is poured with the liquid flowing from the coarser

undecomposed manganese ore into another vessel in which the mixture is steamed or evaporated. Iron oxide or other iron compound may be added for certain shades. If the process be properly conducted, the mass decomposes with water, gas is emitted, an acid solution results, and the colour remains separated in great fineness as a compound of oxide of manganese (and of oxides of iron, if a compound of iron has been added), ammonia, water, and phosphoric acid. Like results may be obtained from other compounds of manganese, iron, ammonia, and phosphoric acid, as well as directly from phosphorous, manganese, and ammonia, with or without nitric acid, and likewise from a solution of burnt bones in hydrochloric acid, and digested with sulphate of ammonia. An analysis of the colour will sometimes present the following approximate analysis:—

Ammonia	6·21
Oxide of manganese . .	28·39
Phosphoric acid . . .	53·89
Water	10·75

The inventor of this process is Anton Leykauf, of Nuremburg.

Cooling Wort and other Warm Liquids.—Narrow troughs of metal are placed on substances which are bad conductors of heat, the liquid is made to circulate through them, or is left in the quiescent state. The external surfaces of these troughs or cooling vessels are kept damp, either by supplying water to them in the form of trickling streams, or by capillary attraction; a blast of air is then made to pass over the troughs, and this is generated by a fan; evaporation is in this way rapidly promoted. The air employed is drawn through an apparatus for drying it, as dry air necessarily promotes evaporation more rapidly than that which is charged with moisture. The substance used to dry the air is fused chloride of calcium. Very rapid cooling is effected by the inventor, Captain Alfred Wilks Drayson, of Woolwich, by the use of carbonic disulphide instead of water.

Manufacture of Phosphatic Manures and Sulphate of Ammonia.—Mr. Arthur Mc Dougall, of Manchester, thus describes his process:—I take animal charcoal or a substitute for animal charcoal (presently to be described), and treat it with sulphuric acid, and then separate the sulphate of lime from the acid phosphate by filtration. I then agitate this sulphate of lime with ammoniacal liquor, resulting from the destructive distillation of carbonaceous substances: by this means I obtain sulphate of ammonia, which I separate from the solution by evaporation. I also evaporate the solution of acid phosphate of lime with a proportion of tribasic phosphate of lime until, upon cooling, it crystallizes as a superphosphate suitable for manures or other purposes in the arts. I also prepare a product, which I can use as a substitute for animal charcoal in the above process, by taking substances in a fine state of division, containing phosphate of lime, and mixing them with small coal or pitch or

other carbonaceous substances, and submitting the mixture to the action of heat in closed vessels. By these processes sulphuric acid is made to do double work: first, to produce soluble phosphates, and then to unite with the ammonia of the ammoniacal liquor to form sulphate of ammonia.

Apparatus for expanding Tables.—In the ordinary method of manufacturing this apparatus, the hollow screws which form the essential parts of it are made by cutting the screw-threads out of the substance of the metal tubes, and in this way the screws are made very weak. Mr. Hare, of Handsworth, Staffordshire, proposes to form the screw-threads upon the tubes by compressing the metal of the tube into the required form instead of turning or cutting away the metal. Screws made in this way are of uniform strength throughout, they are similar to tubes known as cable or twisted tubes. This is no doubt a most useful invention, for it is well-known how infirm tables become after even a short period of use.

Instrument for Treating Rheumatism, etc.—The inventor is M. Charles Baunscheidt, of Bonn. This instrument is used in the treatment of rheumatic affections and other diseases, such as earache, headache, deafness, intermittent fevers, inflammation of the brain, and paralysis, in conjunction with an oil, or oils, or liniment, and more especially the oil known as "Oleum Baunscheidtii." The instrument consists of a metal block or disc, from the face of which projects a number of needles of equal length. This block or puncturer is enclosed in a suitable case, provided with a hollow stem or neck, through which passes a spiral spring attached to the back of the block, and the spring terminates in a handle, which projects from the end of the stem. The block is retained within the casing by a raised rim formed on the interior, and the open end is provided with a cover for the protection of the needles. The instrument is used as follows: The cover being removed, the open end of the instrument is applied close to the skin. The handle, which terminates the spring, is then drawn out from the stem until the spring is sufficiently extended, and the handle is suddenly released. The needles are, by this means, pressed into the skin, which they slightly puncture. The liniment or oil is then painted over the part with a soft brush or feather.

Tarpaulins, etc.—Mr. Nicholas Szerelmey, who is noted for the number and efficiency of many processes for the preservation of materials liable to destruction, has patented a process for making a durable and useful tarpaulin. He boils gas tar, one cwt., until it becomes hard, and at the same time he boils in a steam-jacketed pot fourteen gallons of Stockholm tar spirit, ten pounds of American resin, and one gallon of resin oil. When these ingredients are completely dissolved, they are mixed together, and in about ten minutes after, two ounces of oil of vitriol are added. This compound is found to preserve tarpaulins, sail-cloth, and other fabrics. By an extension of the process, this material

can be made to receive different tints of dark colours, such as reds and browns.

CAST-IRON TILES.—This invention consists in the application for roofing purposes of tiles made of ordinary cast iron, the form and dimensions being varied to suit all purposes, and of a more or less ornamental character. In order to preserve the metal from oxidation, the surface is protected with any suitable paint or varnish, or it may be enamelled. The tiles are usually made three feet square, and the weight of a square yard of roofing, composed of these tiles, is not more than thirty pounds. By the use of these tiles, a saving also may be effected in the number of rafters used; the saving will amount to one-third, or it may be a half, of the cost of ordinary roofing.

MINERAL TEETH.—M. Jean Baptiste Duchesne, Surgeon, Rue Lafayette, Paris, has invented a method of fixing mineral teeth to the dental piece. Each tooth is furnished with a hollow of a size exceeding that of the orifice, by which orifice the rubber in its plastic state enters into the tooth, assuming inside the internal configuration, and, as it were, the shape of a nail-head of a pyramidal form, or of the form of a flattened cone, and the rubber being properly vulcanized, the tooth becomes firmly attached to the dental piece. The hole being obtained by placing on the rear side of the mould of the tooth, which is moulded of materials well-known to tooth manufacturers, the base of a piece of wood, or of any other suitable material, cut into the shape of a cone, and which can be consumed or melted at a lesser degree of heat than that required for the baking of the tooth; this piece of wood or other material being destroyed during the process of biscuiting, there remains in the centre of the tooth a hollow, corresponding in size and shape with the material which has been burnt out. The principle of strength which is claimed for this tooth consists in the fact, that the rubber, a portion of the dental piece to which it is to be attached, entering into the tooth itself, the tooth actually forms part and parcel, so to speak, of the dental piece; and the principle of the invention consists in the hollow in the centre of the tooth of a larger size than the orifice by which the rubber, or other plastic material is introduced, of whatever form this hollow may be, whether produced by the consuming, melting, or annihilating of any animal, vegetable, or mineral matter, that can be annihilated by a lesser heat than that required for the baking of the tooth.

TWO-WHEELED CARRIAGES OR CABS.—The advantages obtained by this kind of carriage is, that the persons riding in the carriage and the driver are immediately over the axle, and therefore the vehicle is perfectly balanced. The strain which, in ordinary Hansom cabs, is borne by the horse is, in this case, avoided. The door is placed at the back of the body of the cab, and it opens outwards. The driver's seat is at the front of the carriage and on the roof, and the axle is placed near the front of the body, and directly under the driver's seat. The seat for persons riding is

situated at the front of the body, and over the axle, and parallel to it; the persons riding thus face the door at the back of the cab. The lower part of the cab is contracted so as to form shoulders, under which one end of each of the springs for supporting the body of the carriage is connected. The inventor, Mr. Richard Gold, of Birmingham, says that, in addition to the balancing of the weight carried by the cab, his invention affords greater convenience and comfort to the riders than cabs of the ordinary kind.

Treating Sewage.—This most important question deserves all the attention which can be given to it. Mr. Jones, of Ealing, surveyor, has proposed to purify and deodorize sewage, by first precipitating the matters in the sewage by the application of slaked lime and shale oil, petroleum, or other hydro-carbon. One bushel of slaked lime to two gallons and a half of shale oil is sufficient to precipitate the solid contents of 100,000 gallons of ordinary sewage. It is, in some cases, advisable to use either a solution of chloride of zinc, sulphuric acid, burnt clay, or a combination of them. Mr. Jones prefers to introduce the precipitating agents into the sewage just before it falls into the depositing beds, where the solid matters collect at the bottom, and the liquid passes through one or two filtering beds (ascension filtering beds being the best) in succession.

LITERARY NOTICES.

The Fern Garden, How to Make, Keep, and Enjoy it; or, Fern Culture made easy. By Shirley Hibberd, author of "Rustic Adornments for Homes of Taste," etc., etc. Illustrated with eight coloured plates and forty wood engravings. (Groombridge & Sons.)—A book as elegant as the objects of which it treats, written in Shirley Hibberd's charming style, and conveying practical knowledge in a most amusing way, is sure of a good reception from the innumerable families who collect and cultivate ferns and their allies. Mr. Hibberd differs from ordinary writers on such matters, no less in positive acquaintance with the subject, than in the agreeable manner in which his information is conveyed. His enthusiasm fascinates, while his pages instruct, and he has not in any former works had a more popular theme on which to discourse. In the present volume he gives hints for Fern Collecting, directions how to form Out-door Ferneries, to Cultivate Rock Ferns, Marsh Ferns, Ferns in Pots, and how to Establish a Fern House. Then we have chapters on the Fernery at the Fireside, Management of Fern Cases, the Art of Multiplying Ferns, British Ferns, Cultivation of Greenhouse and Stove Ferns, Descriptions of Fifty Select Greenhouse Ferns, of Thirty Select Stove Ferns, Gold and Silver Ferns, Tree Ferns, and Fern Allies. The mere enumeration of the contents is enough to excite a fern fever,

and if that disorder should pass into the stage of a violent epidemic, Mr. Hibberd must bear the blame.

Fern collecting, purchasing, and growing, so as to yield a perpetual source of pleasure, and supply elegant decorations for the garden or the house, may be managed at a very moderate cost of cash, and with complete success, if folks will be satisfied with intrinsic beauty and considerable variety; while wealth can luxuriate in the accumulation of expensive treasures from all quarters of the globe, and in the erection of buildings of any dimensions for their preservation and display. The fern lover may accomplish much with shillings if money is scarce, and disburse a little fortune if it is plentiful; but, without discouraging the larger outlay on the part of those who can afford it, we may safely affirm that very moderate means will suffice to obtain the principal varieties of form, tint, mode of growth, etc., which the tribe of ferns offer for our contemplation.

Mr. Hibberd remarks that "some are richly tasselled and fringed, some have duplicated fronds; and the variations otherwise comprise imitation (or resemblances to) stags' horns, frills, fans, wires, bristles, embroidery, braiding, puckering, and embossing. Some of the varieties are notched, as if a child had cut faces out of them; others are shrunk up to mere stalks: some have spores on the wrong side, that is to say on the upper side of the fronds; others never produce spores at all, and a few produce their offspring ready made in the form of little plants at the points of their fronds, or on every part of their leafy surface. Some varieties are so curious, so rare, and so difficult to multiply, that they range in price from one to five guineas a plant. This need not terrify the humble fern collector, for many of the handsomest may be bought for a shilling each." Beginners will save themselves from much loss and vexation if they attend carefully to the instructions Mr. Hibberd gives. Ferns differ much in habit, and in delicacy of constitution, and their ways and whims must be studied if the collector is to succeed.

Bible Animals; being a Description of every Living Creature mentioned in the Scriptures, from the Ape to the Camel. By the Rev. J. G. Wood, M.A., F.L.S, etc., author of "Homes without Hands," "Common Objects of the Sea Shore and Country," etc. With one hundred new designs by W. F. Kehl, F. G. Wood, and E. A. Smith, engraved by G. Pearson. (Longmans.)—We congratulate Mr. Wood on the conclusion of his interesting work, and on the handsome appearance it makes in a stout octavo volume, amply supplied with pictorial illustrations. We have so frequently spoken favourably of "Bible Animals" as they came out in monthly parts, that we have little to add now. As a book for frequent reference and family reading, it is sure to be popular, and its scientific merits are sufficiently respectable. Bible readers meet with innumerable questions of natural history which

it will pleasantly solve, and many a Scripture passage will gain in suggestive beauty through the information Mr. Wood supplies. We cordially wish his labours a long-continued success.

SOUND. A Course of Eight Lectures delivered at the Royal Institution of Great Britain. By JOHN TYNDALL, LL.D., F.R.S., Professor of Natural Philosophy in the Royal Institution of Great Britain. Second Edition. (Longmans.)—The Second Edition of this admirable work differs very little from the first. A few press errors have been corrected, and a summary of M. Regnault's recent researches, contributed by himself has been added. Few scientific works have been more rapidly or more deservedly successful than this admirable treatise, which has been translated into French and German, and republished in the United States. It is a beautifully-written work, eloquent and poetical in style, correct and accurate in expression and thought. It cannot be praised too highly, or too widely diffused. Having, on a former occasion ("Intellectual Observer") noticed the First Edition at some length, we will now confine our remarks to the Appendix. M. Regnault's experiments prove that the elasticity of gases conveying sound is much affected by surrounding bodies—such as the walls of tubes; that a strong sound-wave gives rise to a real transport of the gaseous layers, notably augmenting the velocity of propagation, particularly at the first part of the route. "The discharge of a pistol charged with one gramme of powder generates a sound which is not perceived by the ear after it has passed over:

1159	metres	in	a	tube	of	the diameter of	0·108 metres.
3310	"	"	"	"		0·300	"
9540	"	"	"	"		1·100	" "

"Thus," as M. Regnault observes, "the lengths are sensibly proportioned to the diameter."

M. Regnault also tells us that experiments made with waves produced by the human voice and by wind instruments have demonstrated these principal facts:—Acute sounds propagate themselves with much less facility than grave sounds: In very long conduits, to hear well, it is necessary to employ a baritone: The fundamental sounds are heard before the harmonies, which then succeed each other in the order of pitch: The propagation of sound changes its timbre, which is due to the admixture of the harmonic sounds. In very long conduits, therefore, a tune embracing a certain extent of the gamut would change its character. He gives the mean velocity of a sonorous wave in free air as 330·7 metres.* If the air receives a great shock, as when a cannon is fired, the velocity of propagation near the gun is increased by actual translation of the air—a motion which, however, rapidly subsides, leaving

* 330 metres = 360·899 yards: 331 metres = 361·992 yards. (See "Dowling's Tables.")

the wave-motion only to go on. The velocity diminishes as the wave becomes enfeebled, and the wind diminishes it.

Biblical Notes and Queries. (A. Young & Co., Edinburgh; Partridge, London.)—Works of a theological character are out of our sphere; but we may state that this new serial is intended as a medium of intercommunication between biblical students. The tone seems to be what may be termed liberal orthodox, and the terms of subscription low.

Entozoa: Being a Supplement to the Introduction to the Study of Helminthology. By T. Spencer Cobbold, M.D., F.R.S., Correspondent of the Academy of Sciences of Philadelphia. (Groombridge & Sons.)—Dr. Cobbold's splendid work on Entozoa, published nearly five years ago, is now judiciously supplemented by the present volume, which may be regarded as its continuation and completion. It supplies an addition to the bibliographic list in the original volume which will be of great use to students; and likewise an Index, which will materially add to its convenience and value. Dr. Cobbold details, in the pages before us, a remarkable series of experiments on the *Trichina spiralis*, the *Tænia mediocanellata*, *T. marginata*, and *T. cœnurus*. He also gives an account of the pseud-entozoa of diseased and healthy cattle; the entozoa infesting dogs, fowls, and game-birds; observations on the *Distoma clavatum* of the sword-fish, and the so-called *D. elephantis;* and he adds a chapter on Organic Individuality.

Dr. Cobbold deserves great credit for his persevering study of the Entozoa. He has done more than any other Englishman in this important branch of science; and the "Supplement" now issued well deserves the consideration of naturalists and of the medical world.

The Birds of Sherwood Forest; with Notes on their Habits, Nesting, Migrations, etc. Being a Contribution to the Natural History of the County. By W. J. Sterland, with four Illustrations by the Author. (L. Reeve and Co.)—Good local works on natural history are always valuable, and the good opinion formed of Mr. Sterland's labours when they appeared in the shape of letters to a newspaper will be increased by their issue as a book with some additional matter. Mr. Sterland is evidently a good observer, and he has something interesting and frequently original to say about each bird he describes as haunting the famed forest of Robin Hood. Most of the birds mentioned are common in various other districts, and the author's account of them will be read with pleasure and profit by those who live far from the scenes he depicts. We thoroughly endorse his protest against the wanton destruction of hawks, owls, magpies, jays, etc., as well as of sparrows and smaller birds. Country gentlemen ought to check their gamekeepers' mania for exterminating many of our most interesting feathered tribes. No doubt some of them may do harm to game, but such is not their exclusive function, and most, if not all, offer ample compensation by their attacks on noxious creatures of various sorts. If a little more knowledge

of natural history can be got into the sporting skull, and a little more taste for observation, the owners of large estates will acquire something of the Charles Waterton spirit, and take pride in sheltering all the wild animals that are not absolutely dangerous or very positively mischievous.

Mr. Sterland mentions many curious facts in the course of his work. For example, he tells us of a sparrow which learnt to imitate a lark, and he mentions an instance of a martin whose nest was thrown down and partly demolished in a storm, sitting placidly in it while a good-natured man put it up again and replaced her young. In one passage he speaks of representations of the martin's nest open at the top as a mistake, but we have recently noticed this very fact in a nest built in Sussex under the eaves of a cottage, and being a mere cup somewhat irregular round the rim. Other nests attached to the same cottage, and also constructed during the present season, have the more usual form, with one roundish hole for entrance; but the nests of these birds will not always be found exactly alike, and mere copies of a typical pattern. In commenting on that interesting bird the nightjar, Mr. Sterland expresses his belief that the peculiar structure of the foot, with its toothed claw, enables it to hold fast while sitting along a bough and not across it. In his remarks on water birds he disputes the common statement that they grease their feathers with material squeezed out of their oil glands. "The Birds of Sherwood Forest" is a work we can recommend for pleasant reading as well as for information.

On some Fossils found in the Eophyton Sandstone at Lugnås in Sweden. By J. G. O. Linnarsson, with Three Plates. (Stockholm: Norstedt and Söner.)—This is a translation of an important paper read before a Swedish society. It describes a lingula found in a bed assigned to the Cambrian series, and likewise a very curious fossil the *Eophyton Linneanum*, the exact nature of which is still uncertain, but which the writer supposes to be a vascular cryptogram. There is also an account of the *Rhysophycus dispar* resembling the *Rusophycus* and *Rusichnites* of Canada. The age of these fossils invests them with especial importance.

NOTES AND MEMORANDA.

The Alleged Poisoning by Coralline.—M. Landrin has reported experiments to the French Academy, tending to show that pure coralline does not exert any poisonous action on the human skin. M. Tardieu rejoins, that the coralline-dyed stockings which he examined, and which did produce such effects, did not contain arsenic, lead, mercury, or other mineral poisons, but he cannot say whether or not the stockings were coloured with coralline only. So the question stands in a position of uncertainty as to the real cause of the mischief imputed to this pretty dye.

Frog Poison in New Granada.—M. Escobar informs the French Academy that the natives of New Granada torture the *Phyllobates melanospinus* in a horrible way, and

then scrape the secretions from its skin; which he states is virulent enough to animals as large as a man or a jaguar.

Oxygenized Water in the Atmosphere. — M. H. Struve states ("Comptes Rendus") that he has discovered this substance in the atmosphere, and that it is found there like ozone, or nitrate of ammonia, and precipitates from it. He says that the change produced by the atmosphere on iodo-starch paper are occasioned by oxygenized water and ozone.

Optical Phenomena of Opals.—Mr. Crookes has a paper on this subject in "Proc. Roy. Soc." He states as the result of spectroscopic examination of opals, that those parts which emit red light are opaque to light of the same refrangibility; and after examining in the same manner opals which shine with green, yellow, or blue light, the same appearances are observed, showing that this rule holds good in these cases also.

Heat of the Moon.—Experiments made by Lord Rosse, and detailed in "Proc. Roy. Soc.," tend to show that a very small portion of the heat radiated by the moon and reaching the earth can come from her interior. He thinks the heat absorbed from the sun may raise the moon's surface during her day to 500° F.

Sedative for Burns.—"Cosmos" states, that to relieve a child who was fearfully burnt, M. Joel, of the Hospice de l'Enfance, at Lausanne, placed it in a tepid bath, in which he put two handfuls of sulphate of iron, which immediately relieved the pain and checked a fetid suppuration. The child was placed in this bath for fifteen or twenty minutes, twice a day.

The Pascal Forgeries.—It now appears that twenty notes, purporting to be signed by Pascal, are copies of a chapter of a work of Savarien. M. Chasles is, however, no more affected by this discovery than by other proofs of the unauthenticity of his bundle of MSS. He accuses Savarien of having copied Pascal!

The Sutherland Gold Fields.—A paper on this subject was read, in June, by the Rev. J. M. Joass, before the Geological Society. He described the gold district as extending twenty miles in the S. E. of Sutherland, from north to south, and about thirty from east to west. The prevailing rocks are flaggy quartzites and micaceous beds, dipping S. E., and belonging to the Lower Silurian system. Sir R. Murchison expressed his belief that no considerable body of rock charged with rich auriferous bands would be discovered in the North Highlands. Mr. Joass said, "If the gold of Sutherland be derived from the binary compound of felspar and quartz, so abundant in Suisgill and Cill Donnan, the Caithness district does not seem to be richly auriferous; as this rock, so far as could be seen, is not plentiful there." He thinks it possible that this is the matrix of the gold, but none has yet been found in the rock *in situ*. He thinks the Pictish towers, sixty of which are in Sutherland, and thirty in the Cill Donnan district may have been erected to keep mountain invaders away from the gold.

Mortality in Large Hospitals.—From the researches of Professor Simpson it appears that in London, Edinburgh, and Glasgow, out of 2,089 patients suffering amputations of limbs, 825 die; while in country hospitals the deaths in the same number only amount to 226. In country cases 377 patients suffered amputation of the fore-arm with one death in 188; while in the great town hospitals there was at the rate of one death in six. Thus the great hospital mortality was thirty times as much as in the country hospitals. Amputations of the thigh gave the same results, the comparison being at the rate of 1 to 1·5 in the great towns, and 1 in 4 in the country. The mortality in the great Paris hospitals is likewise in enormous excess of that in rural practice.

THE "INNIS VEAN" AND LIZARD HEAD, CORNWALL

CORNISH SERPENTINE.

BY PROFESSOR CHURCH, M.A.,

Of the Royal Agricultural College, Cirencester.

(*With a Coloured Plate of the Lizard Rocks.*)

SERPENTINE is the most varied and beautiful of all English rocks used for ornamental purposes, and is, probably, very nearly, if not quite, as durable as any of them, and is certainly superior in this respect to the true marbles. It is by no means common. The chief locality for it in England is the Lizard district of South-west Cornwall; in Wales it occurs at Holyhead, in the island of Anglesea; in Scotland it is found in Banffshire, Aberdeenshire, and the Shetlands; while in Ireland, Mayo and Galway afford a curiously variegated sort known as Connemara, or Irish Green.

Serpentine, as a rock, should be distinguished from serpentine as a mineral species. The former is often a mixture of many substances, the latter is a definite compound—a hydrous magnesium silicate. Although the outward aspects and properties of different specimens of the mineral serpentine vary greatly, even when obtained from the same locality, yet in chemical constitution they are practically identical. The empirical formula assigned to pure serpentine may be written in several ways:

I. $3\,Mg\,O, 2\,Si\,O_2, 2\,H_2\,O$; or
II. $Mg_2\,Si_2\,O_6, Mg\,H_2\,O_2$, aq.; or
III. $Mg_3\,H_2\,Si_2\,O_8$, aq.; or
IV. $Mg_3\,H_4\,Si_2\,O_9$.

It is probable that the best of these expressions is the third, in which the compound is regarded as a hydrated magnesic disilicate, in which one atom of magnesium is replaced by two atoms of hydrogen. The precious or noble serpentine, a variety which occurs very sparingly at the Lizard, approaches most nearly to the theoretical composition of the pure mineral. It is translucent, of greenish yellow colour, and much softer than the darker and more impure varieties, in fact it is but slightly harder than gypsum, and may be scratched by calc-spar. It contains about one per cent. of the iron oxides, ferrous and ferric, which are present in much larger proportion in the more richly coloured and variegated sorts of serpentine. But the spots and streaks, the clouds and veins upon the serpentine rock, which suggested not only the word serpentine, but the name of the chief district of England where this rock occurs, are not due

merely to variations in the amount of iron. The red spots characteristic of much of the Lizard serpentine, do certainly contain much iron in the condition of the ferric or peroxide, while the dark green varieties of the rock contain considerable amounts of the ferrous or protoxide, but the occurrence of perfectly distinct mineral species in the massive serpentine, makes its aspect still more varied. Among these intruding minerals may be named diallage, steatite, magnesite, dolomite, and calcite. One of these minerals, diallage, occurs in the serpentine of Veryan and the Manacles, and imparts great richness to the appearance of the rock by its dark metallic-looking crystals. All the other minerals named are usually white (although sometimes the Lizard steatite is pink), and occur in undulating layers, sometimes as thin as paper, sometimes a foot or more thick. These layers generally appear on the surfaces of the rock as veins. These so-called veins are to be seen more or less developed in almost every large mass of polished serpentine, and though usually spoken of as steatite, or soapstone, very often consist chiefly of the carbonates of calcium and magnesium, and this is especially the case with the thinner white layers. It has been stated that the veins of steatite are sometimes large. Conspicuous examples of this kind may be seen at Coverack Cove, and between Black Head and Pedn Boar; also at Mullion Cove and Gue Graze. The steatite from some of these points has been worked on a considerable scale, having been used not only in the Staffordshire potteries, and the Swansea porcelain works (now abandoned), but also for the manufacture of magnesium salts.

The serpentine of the Lizard district occupies a rather limited extent of country. On the coast west of the Lizard Head, we may specially note its occurrence at Mullion, Pradanack, and Kynance. The exquisite beauty of the coast at Kynance Cove is a matter of notoriety. The clear sea, a chrome green, here and there darkening with violet and edged and flecked with foaming white; bright sand streaked with lines of serpentine pebbles; and, above all, cliffs and islands, and cavernous recesses varied in form and splendid in colour, —all these things, with the charms of a varied atmosphere and the rare heaths, clovers, ferns, and other plants to be found about the coast, make Kynance a place which neither words nor colours can adequately represent, or even recall. Our coloured picture is taken from the cliff near Kynance, but looking away from the Cove and towards the Lizard Head, which is seen in the distance, while in the waters beyond we catch a glimpse of the rocks called the Stags, and the Man-of-war rocks. The rock in the foreground, capped

with rich lichen is known as Yellow Carn; it is a mass of serpentine, its seaward side brilliant with purple and crimson. Between it and the cliff is a remarkable block, also of serpentine, known as the Innis Vean. The cliff itself consists in part of the green fibrous variety of the same rock.

Leaving Kynance we soon reach Lizard Head, which consists not of serpentine, but of gneiss, chlorite, and mica slate. To the east of the Lizard Head, Landewednack, Cadgwith, Kildown Point, Caerleon Cove, and Coverack Cove, are localities where serpentine occurs abundantly and of fine quality. From these and some other points in this district, this beautiful rock has been quarried for architectural and ornamental purposes. It is impossible to describe the exquisite and intricate beauties of structure and colour found in Cornish serpentine, so we must content ourselves with referring our readers to the numerous specimens of it which may be seen in many recent monuments and buildings in London, and in some of our large towns. A very good suite of polished specimens may be studied in the Museum of Practical Geology, Jermyn Street. This collection embraces serpentines of foreign, as well as English origin. An American specimen, nearly transparent, and of an emerald green colour, comes from Texas, Lancaster County, Pennsylvania, and has been employed in jewellery. It is usually spotted with crystals or masses of black chrome-iron. Among the Cornish specimens in Jermyn Street, occur some of the fibrous variety not yet alluded to. They differ in colour greatly, some being golden yellow, some olive green, while others are of a purple brown tint. The last-named sort is of singular beauty, the fine fibres of which it consists giving it a dark purplish brown colour, or even a brilliant coppery reflection, according to the manner in which the light falls upon it. But of this serpentine as of the other innumerable varieties as to structure and colour, a true idea can only be obtained by careful examination of polished specimens, and of thin sections, viewed under the microscope. Serpentine is at once tough and yet easily worked; it takes a good polish, and is little affected by atmospheric agencies; it is on these accounts adapted for external as well as internal architectural decoration.

In the present paper we have not spoken of the Lizard serpentine from a geological point of view; the relations of this rock to the other formations of the district are in fact in some particulars obscure, while the subject lies beyond the scope of the present brief note.

THE ANNELIDAN WORMS, OR ANNELIDES (ANNELIDA).

BY W. BAIRD, M.D., F.R.S., F.L.S., ETC.

(*Continued from* Vol. III., *page* 440.)

FOURTH ORDER.—SUCTORIA—THE SUCKING WORMS.

THE body of the worms belonging to this Order is simple, always naked (except in one genus, which is distinguished by its having on each side a series of branchial-looking foliations, Branchellion), elongated, cylindrical, but more or less depressed, sometimes a little swollen out on the back, and flat or slightly concave in the abdominal region; slightly attenuated at the anterior extremity, and terminated at each end by a dilatable, prehensile expansion called a *sucker*. The first of these, the anterior, is generally called the *head*, or *oral sucker*; the second, or posterior, is generally designated as the *acetabulum*, or *ventral sucker*. The body is more or less distinctly annulated, sometimes set all round with small tubercles or warts, which are numerous, and generally smaller at the anterior extremity. It is usually soft, and more or less viscous, though in the genus Pontobdella the skin is hard and coriaceous.

The leech family are capable of taking different forms while in a state of contraction: sometimes they are oval, at other times curved on the ventral aspect, and at others again they roll themselves up in a ball like the Cloporti amongst the Crustacea. In all the genera we see four openings in different parts of the body—one near the anterior extremity, the *mouth*; the second at the posterior extremity, or dorsal aspect, the *anus*. The two others are situated in the lower part of the abdomen, near the anterior third of the body; one the male orifice, the other that of the female. In the skin we see a number of mucous crypts, which open outwardly, and give issue to a quantity of slightly viscous fluid of an unctuous nature which lubricates the skin. The movements of the Suctoria are made by means of the suckers. The animal places its ventral sucker in such a manner that it is glued, as it were, to the surface it lays hold of, the more highly polished the better, so as to completely exclude all air; not by forming a vacuum, as many suppose, but by direct application round the whole surface embraced by it. It then elongates the body till it arrives at the point of extension desirable, when it fixes there the anterior sucker. Releasing the ventral sucker, it contracts the body upon a new point, and causes it to approach the mouth; and thus by repeated alternate move-

ments it progresses forwards. This operation is performed, and the animals move with considerable rapidity.

The greater portion of this Order of animals live in the water, either swimming in it or remaining fixed at the bottom of the ditches, etc., where they are found, upon stones, in the mud, or on aquatic plants. Sometimes we see them move to the surface, and then when they wish to descend they roll themselves up in a ball, and allow the body to fall slowly in the water.

The nervous system of the Suctoria is composed of a medullary collar, analogous to that of the worms of the other Orders already mentioned, of a long chain of ganglia, and numerous fine nerves. (See the nervous system exhibited in Plate I., Figs. 1—3.) The medullary or buccal collar surrounds the commencement of the esophagus, and we have a pre-esophageal and post-esophageal ganglion, as in the case of the Nereis, Lumbricus, etc.

The Suctorial Annelides are very sensitive to the influence of anything irritating the skin. Every one almost knows, for instance, the effect which salt has upon the medicinal leech, what violent convulsions it throws the poor creature into, and how by this influence it is made to disgorge the blood it has swallowed. They are, likewise, sensitive to the action of light and heat. It is a very common thing to keep leeches in a bottle as a barometer, so as by their actions of rising and falling in the bottle to foretell the changes of weather.

The chief organs of touch are the suckers, and it is the anterior that is most endowed with this sense. They appear also to enjoy, in a considerable degree, the sense of smell. Leeches, for instance, will not fasten upon any part of the body that has had the skin surrounded with plaister, ointment, etc. Eyes are present in all the order. The ocelli, as the black specks generally assumed to be eyes are called, vary in number, but are always situate on the upper part of the anterior sucker, though they vary in position. They are always placed in pairs, and number from two to ten, in different genera. These ocelli are usually projecting, and as Moquin Tandon observes, they are extremely sensitive, more as organs of touch than sight, the sense of vision being only sufficiently developed to enable them to feel the influence of light, and not perceive objects. The digestive organs are well developed, and extend in a straight line from the oral to the posterior sucker. They consist of the mouth, esophagus, stomach, intestine, and anus. The mouth is situated in the oral sucker, is nearly terminal, and is generally of a triangular form. In most of the typical genera, as

Hirudo, etc., the mouth is armed with three hard papillæ, called jaws or teeth, disposed in the form of a triangle, and generally denticulated or serrated on the margin. If we examine the wound made by the bite of the medicinal leech, we shall see it always triangular, arising from this position of the teeth. In the genus Branchellion the jaws or teeth are only two in number, and in Pontobdella, Piscicola, etc., they are reduced to a scarcely visible point. The esophagus is in general more or less straight, but bulges out a little in the middle. In many of the genera it is very large. The stomach is in form of a more or less longitudinal canal, extending from the esophagus to about the two-thirds of the posterior portion of the animal. In many of the genera it is divided into a series of compartments or lobes; in the case of the genus Hirudo there are eleven pairs of these. Some others of the genera, however, differ in having very few distinct lobes, or even none at all, only a sort of constriction in different portions. The intestine is a continuation of the stomach; in those species which have the lobes distinct it commences immediately after the two last lobes, and in general is a slender canal, which extends, slightly narrowing, till it terminates in the anus. This is situated in the dorsal region of the animal, close to the commencement of the posterior sucker, and is usually very small, even scarcely visible in many of the genera. In others it is distinct, large, and surrounded with a considerably strong sphincter.

The vascular system of the Suctoria consists chiefly of four longitudinal trunks, which extend from the oral to the anal suckers. One of these is called the dorsal vessel, the other the ventral; the two others are called lateral. From these main trunks small branches go to the different parts and organs of the body. (*Vide* Plate I., Fig. 1, for a general view of the circulation in the Annelides.)

The blood of these worms is red, or at least of a reddish hue for the most part, and in the true leeches we find distinct globules. The movement of the blood is by pulsations, which in some of the genera are in number from six to twelve or fifteen in the minute. Most probably the dorsal and ventral vessels carry the blood into the different parts of the body, and it returns by means of the lateral vessels, which bring it into contact with the organs of respiration, and then send it by contractions into the two before-named vessels.

The suctorial Annelides do not appear to have any particular organs of respiration, but this function seems to be carried on

through the whole cutaneous covering of the body. These Annelides are hermaphrodite, that is, each individual combines both sexes in itself. A copulation between two worms, however, is necessary for the fecundation of the ova. They are all oviparous. Some lay their eggs singly or isolated, others deposit them united together in a variable number. When the envelope which surrounds them is thin, naked, or only covered with a slight viscous coat, they are called *capsules;* when it is surrounded by a spongy tissue, they are known by the name of *cocoons*. This cocoon, in the case of the medicinal leech, resembles very much the cocoon of the silkworm; and being of a spongy nature, may easily be mistaken for sponges. These ova require either to be deposited in water or in a damp place, in order that the young may be developed. As soon as these young are sufficiently advanced, they burst the bonds which held them in the capsule or cocoon, and issue forth at the end of from twenty-one to thirty days, according to different genera, though they appear for a short time to keep close to the mother, or to the envelope which sheltered them.

Systematic Arrangement.—The order Suctoria of MM. Audouin and Milne Edwards, has been also called Discophora by Grube, and Bdellidea by Blainville. Late Helminthologists have removed from the Entozoa, or parasitical worms, several of the genera usually arranged with them, and have arranged them with the Suctorial Order of Annelides. In many cases, these authors are, no doubt, correct; but we will confine our attention, in the following brief exposition of this Order, to those genera universally acknowledged to belong to it, such as the skate-suckers, the fish leeches, the true leeches, etc.

The first tribe of this Order that calls for our particular notice is that of the Hirudinacea. After the full anatomical description of the worms belonging to this Order, chiefly in reference to this large and typical group, we will now only mention the leading characters by which they may be known.

The body is elongated, cylindrical, or depressed, tapering more or less towards the two ends, and usually composed of very short rings. It is provided in front and behind with a sucking disc or cup. The head lobe is hollowed beneath, and forms with some of the anterior rings, the oral sucking organ. This is usually annulated itself, and somewhat separated from the other segments; but occasionally, though rarely, the head lobe is destitute of rings, and is completely amalgamated with the other segments. The eyes, when present, are from two to five pairs, placed partly on the

anterior disc, partly behind it. The mouth is situated at the bottom of the anterior cup, or disc, and is directed downwards. The pharynx is slightly exsertile, and is furnished with three longitudinal folds. It is sometimes hard and armed with teeth suited for cutting. Lateral processes, or branchial-looking appendages, are only observed in one genus (Branchellion) when they are foliaceous in general, rarely filiform. The openings of the sexual organs are not in pairs, but are placed close behind one another in the central line of the ventral surface.

The species are all aquatic, and are more or less parasitic in their mode of life, sucking the juices of other aquatic animals. A few, however, that will be mentioned hereafter, feed upon living animals, swallowing them entire.

A curious genus may be first mentioned. The "branchial leech," Branchellion, sometimes called Branchiobdella (the type of the family Branchellidæ). The body is leech-like; but the oral sucker is separated from the body by a constriction, and is supported on a long cylindrical narrow neck issuing abruptly from it. On each side it has a (variable) number of appendages or lobes, foliaceous or leaf-like in form, commencing below where the neck begins, and extending to a greater or less distance down towards the tail. These have been considered by some authors as real branchiæ; but though that opinion is no longer tenable, Quatrefages maintains that they do assist in aërating the lymph or chyle previously to their admixture with the blood. The oral sucker is small, much less than the ventral, which is circular, quite terminal, and generally studded with small granules. Only one or two species have been hitherto described. The *Branchellion torpedinis* is found parasitic on the body of the electric ray (Torpedo) and a specimen, now in the collection of the British Museum, has been taken in the British seas. Several others, new species, about to be described, have been found parasitic upon sharks, etc., in Australia, and elsewhere.

Another genus, of which there are several species found in the British seas, is the "skate-sucker," Pontobdella (belonging to the family Piscicolidæ). The genus is known by its elongate, cylindrical body, being of a coriaceous character, more or less covered with warts, and having no branchial-looking appendages on the sides. The anterior portion of the body is usually narrowed, but it has not the constriction which marks that part of the body in Branchellion. The body is distinctly ringed in general, or divided into unequal-sized segments, which vary in number from about fifty to seventy. Both

suckers are of considerable size, completely circular, sometimes the posterior, at others the anterior being the larger. Savigny says that these creatures possess six eyes, but they are not easily to be seen. The most common species of Pontobdella found in our seas is what the fishermen on our coasts call the "sea-leech, or skate-sucker," *Pontobdella muricata*. The length of this animal is about four inches, and the coriaceous skin is covered with small tubercles, or warts, which are spinulose on the top. It lives a parasitic life upon fish, chiefly the skate—hence its common English name—and is scarcely ever found free and unattached. As the mouth is not provided with jaws, the animal makes no wound, but merely sucks up the juices of the body of its host, by a sort of pumping process. The eggs are contained in capsules, one fœtus to each capsule. These are attached by the base to foreign bodies, where they remain till the young are ready to be hatched, and make their escape.

A small species of leech is found on fishes living in fresh-water lakes: this is the *Piscicola geometra*, the "great-tailed leech" of Hill and the early English authors. It is a small narrow worm, the suckers not placed quite centrally, the posterior rayed with fuscous colour, and the body marked with rows of blackish dots, alternating with light rings, without spots. It may be found on such fishes as inhabit fresh-water lakes, as the perch, carp, etc. The suckers are large in comparison with the size of the animal, and it is said, by means of these, they can walk on the surface of the water as well as on a solid body.

The family, Hirudinidæ, contains the true leeches, one of which, at least, is so well known. Their body is composed of more or less distinct rings, and their oral sucker is continuous with the body. The true leeches are purely suctorial, and only live by sucking the blood and juices of various other animals upon which they fasten. When gorged, they fall off, and live a free, non-parasitical life, leaving the water occasionally, and taking up their abode in damp situations.

The medicinal leech, *Hirudo medicinalis* may be taken as the type of this limited family. We have given as our illustration of it, a figure of a fine variety of this leech, called by Quatrefages, *Sanguisuga vacca*.* In Cuvier's illustrated edition of the "Regne Animal" it is called the *Hæmopis sanguisorba*, but Grube properly considers it to belong to the genus Hirudo, though he queries the species as a distinct one. I consider it only a variety of *Hirudo*

* See Plate opposite page 321, Vol. III.

medicinalis (Plate IV., Fig. 7). As we have stated in our introductory anatomical remarks of the Order, the mouth of the leech is armed with three jaws, or teeth, disposed in a triangular form, and serrated on the margin with numerous small denticulations. With these teeth they are able to pierce the skin of the animals upon which they fasten, and thus suck the blood of their host. The alimentary canal is deeply lobed, the two last lobes being elongated like an intestine, and in these the blood can remain for a length of time undigested. Their eyes are five pairs; there are six on the first segment, two on the third, and two on the sixth, remote from the others—all placed on a curved line. The oral sucker has a thick, entire rim, and the posterior is rather small, with a radiately-plaited margin.

There is another species of leech in this family, belonging to the genus Hæmopsis, which, on the Continent, is frequently called the "horse-leech." This species only differs from those of the genus Hirudo, by their jaws, or teeth, having fewer denticulations, and these being blunter; and by the ventral sucker being large in comparison with the oral. In consequence of the teeth being less numerously denticulated, and these denticulations being blunter, these leeches are not used for medicinal purposes, their bite being more difficult to heal. This leech is called *Hæmopsis sanguisuga*. Both these species are nearly of equal size, and both lay their eggs enclosed in a spongy cocoon.

Leeches can endure a long abstinence from food, without apparent detriment. They have been kept for two or three years in pure water, without food, and even then only seem to lose in size.

Moquin Tandon describes at considerable length, and with some minutiæ, the manner in which the leech makes its bite. It first, he says, elongates the oral sucker, and contracts the two lips. The jaws, or teeth, are then pushed forwards. Having taken into its mouth a small portion of the skin of the animal upon which it begins to feed, it presses upon it with its teeth, and, by alternate contractions and prolongations, it succeeds in cutting the part so acted upon in three places, these teeth acting like three small toothed wheels, or three very fine saws of an arched form. The wound so produced has exactly the appearance of three slight cuts, uniting in the centre, and forming three converging angles, nearly equal to each other.

The digestion of the blood sucked up by the leech appears to be a long time in being completed: some authors say that the process endures for from six months to two or three years. According to

Moquin Tandon, it lasts from six to twelve months, according to the quantity of blood swallowed. Leeches grow very slowly. According to some authors, it takes several years for a leech to arrive at maturity, and that at least twelve or eighteen months must pass before they are capable of being used medicinally.

The use of leeches in this country has amazingly decreased within the last twenty years. In London they are seldom used; but at one time immense quantities were brought to this country from the Continent, and the fishery for these Annelides was an important means of livelihood for vast numbers of persons. Moquin Tandon informs us that, in the city of Paris, in 1825 and in 1830, three millions of leeches were used. Calculations were made about that time, which went to prove that in France alone the annual consumption of leeches for medicinal purposes amounted to from twenty to thirty millions! and that about an equal number were used in England. In Paris, at one time (about the year 1824), local blood-letting was considered one of the most important means for curing diseases; and M. Fee tells us that, at that time, elegantly-dressed ladies were in the habit of wearing dresses adorned with the figures of leeches!

At the time Moquin Tandon wrote his "Monograph of the Hirudines," he seemed to fear that the immense quantities used had exhausted the supply in France, and that Spain and Portugal had also ceased to be able to meet the demand, the marshes and ponds in all these countries having been completely impoverished. Now that leeches in medicine are so much disused, no doubt the supply will naturally increase of itself.

The true leeches, belonging to the family Hirudinidæ, are the most typical species of the Suctoria. There are others, however, which, possessing the characters of the oral and anal sucker, etc., differ in some other respects, and have, therefore, been placed in separate small families by themselves. Such is the family Nephelidæ, the jaws, or teeth of which, are merely rudimentary, and, therefore, the species contained in them are disabled from piercing the skin of other animals. The digestive canal is more simple in structure in this family, the stomach being only merely lobed, and only occasionally is there any appearance of the long appendages. The species are all natives of fresh waters, but they are able to leave the water, and take up their abode under stones, in damp places. They deposit their ova in capsules. The species of this family, unlike the preceding, are strictly carnivorous, preying upon living animals existing in the same ponds as themselves.

The species of the genus, Nephelis, are very few in number, and are small leeches, indistinctly annulated, and having the two suckers, both oral and anal, obliquely terminal, or ex-central. They possess eight eyes, which are very distinct, four in a crescentic shape on the first segment, and four on the sides of the third, in lateral and transverse lines.

One species is common enough in our ponds and ditches, the "eight-eyed leech," *Nephelis octoculata*. This is a small leech, from one to one and a half inches long, and two or three lines broad. The colours vary much, but in general the little animal is of a more or less deep brown, sometimes one-coloured, at others speckled with yellowish or black dots and lines, or prettily tesselated with yellowish quadrangular spots, arranged in a more or less regular pattern. The varieties are numerous, chiefly with regard to the distribution of their colours. Moquin Tandon describes twelve varieties, and Savigny has described four of these as distinct species. When the colours are not too obscure, and the little creature is more or less transparent, we can see through the parieties, the ventral and the two lateral vessels, as well as the transverse branches.

The "eight-eyed leech" is a very active animal. It moves like the horse-leech, and swims by an undulatory, or serpentine motion. It does not leave the water, but often takes up its abode under stones or submerged plants. Observers tell us that these Annelides seem to like fixing themselves to some object by means of their ventral sucker, and then waving their body to and fro in a constant undulatory motion. They deposit their eggs in capsules, five or six to each individual, and each capsule contains from six to even twenty ova, embedded in a gelatinous mass. These ova go through the various stages, and the young escape from the capsule in from thirty to seventy days, according to the temperature.

The "eight-eyed leeches" are carnivorous animals. Muller says that they swallow microscopical worms, and even small-shelled mollusca, that are common inhabitants of the same water. Johnson says they feed on small earth-worms, which they swallow whole; and Sir John Dalyell tells us that they are fierce, active, and voracious creatures, feeding greedily on flesh, "and even waging a destructive warfare against their own tribe." They also appear to feed upon Planariæ, fresh water Entomostraca, etc.

The leech, commonly called in many parts of this country the "horse-leech, or blood-sucker," *Aulastoma gulo*, belongs to this family. The jaws, or teeth, of this animal are not formed, like those of the other horse-leech already mentioned, *Hæmopsis sanguisuga*,

for penetrating the skin or flesh of animals. They are wide apart, but slightly compressed, and the denticles upon their free edge are larger and blunter than those of the medicinal leech, consisting only of about fourteen. So that, instead of being formed for penetrating the flesh, they may, as Moquin Tandon observes, be compared to the molar teeth of vertebrated animals.

Extended to its full length, this horse-leech is about four inches in length, is of a linear, oblong shape, narrower anteriorly, and on the dorsal region of a uniform deep brown, or olive, or black colour, the abdominal surface being yellowish-green. The body is less distinctly annulated than the medicinal leech, and has the head rounded, but not dilated. On the crown we see ten eyes, which are arranged in a semi-circle, the two anterior being larger than the others. Dr. Johnston says this leech "seems always on the look-out to escape from its confinement in water; and it is oftenest found under stones, just above the water-line of its pond. It moves by stretching the body to the utmost from the anal sucker, by which it has anchored itself, attaching the mouth, and then dragging the body onwards, without raising it much above the surface. It swims with grace and ease in the water, like an eel." Sir John Dalyell tells us that it is an active, bold, and clever animal, and that none of the tribe surpass it in voracity. Earth-worms, larvæ of aquatic insects, etc., are the substances it feeds upon; but few animal matters are rejected. The eight-eyed leeches, and the young medicinal leeches, fall victims to its appetite, and dead fishes are greedily devoured.

Many ridiculous tales are told of the "horse leeches." It is frequently said, that they fasten themselves upon people's limbs that are in the water, and that they attach themselves so fast, that they cannot be removed; and as it is the firm belief of the vulgar that the blood flows from the posterior aperture as quickly as it is sucked in by the mouth, danger, and even death, may be dreaded. "The origin of this belief is easily to be traced," says Dr. Johnston; "there was (and is) a yearning wish, long cherished by holy men, to identify every animal mentioned in Scripture with some one that was familiar to them, and could be readily referred to in illustration of the text; and hence, our harmless and insignificant worm stood as the representative of the horse-leech which 'hath two daughters, crying, give, give.'" In reality, however, "the horse-leech which had such attributes assigned to it, is unable to bite and draw blood."

Several other species of leeches belonging to this family are

found in this country. We have not space to enter into a description of these, but we may briefly mention one, belonging to the genus Trocheta, a species of which has occasionally been found in Great Britain. A specimen of this leech, *Trocheta viridis*, was lately found in the gullet of a deer which died in the Zoological Gardens; and one or two other specimens have been found at large in the same locality. They are semi-terrestrial animals, and are eminently carnivorous, as they frequently leave the water to prey upon earth-worms. The remaining members of this Order of Annelides we must still more briefly discuss.

In addition to the tribe Hirudinacea, just mentioned above, there is another, called Clepsinea, and in this tribe there is a family of British leeches, called Glossoporidæ. This family consists of small leeches, usually very transparent, and distinguished from all the other families already noticed by their possessing a cylindrical proboscis, capable of being extended at will from the oral aperture, by their being more strictly geometric in their mode of progression, and by their contracting their body into a ball, when alarmed, in the same manner as the wood-louse does. The ova are not enclosed in a capsule, and the young are carried by the parent, attached to the belly, for a considerable time after birth. They live in pure fresh water, but are not capable of swimming. They are slow in motion, and cannot exist out of water, perishing soon after being taken out.

The species found in this country are all small, and rather insignificant creatures; but not fewer than eleven or twelve have been either described or indicated.

CORALS AND THEIR POLYPES.

BY P. MARTIN DUNCAN, M.B. LOND., F.R.S.,

Fellow of and Secretary to the Geological Society.

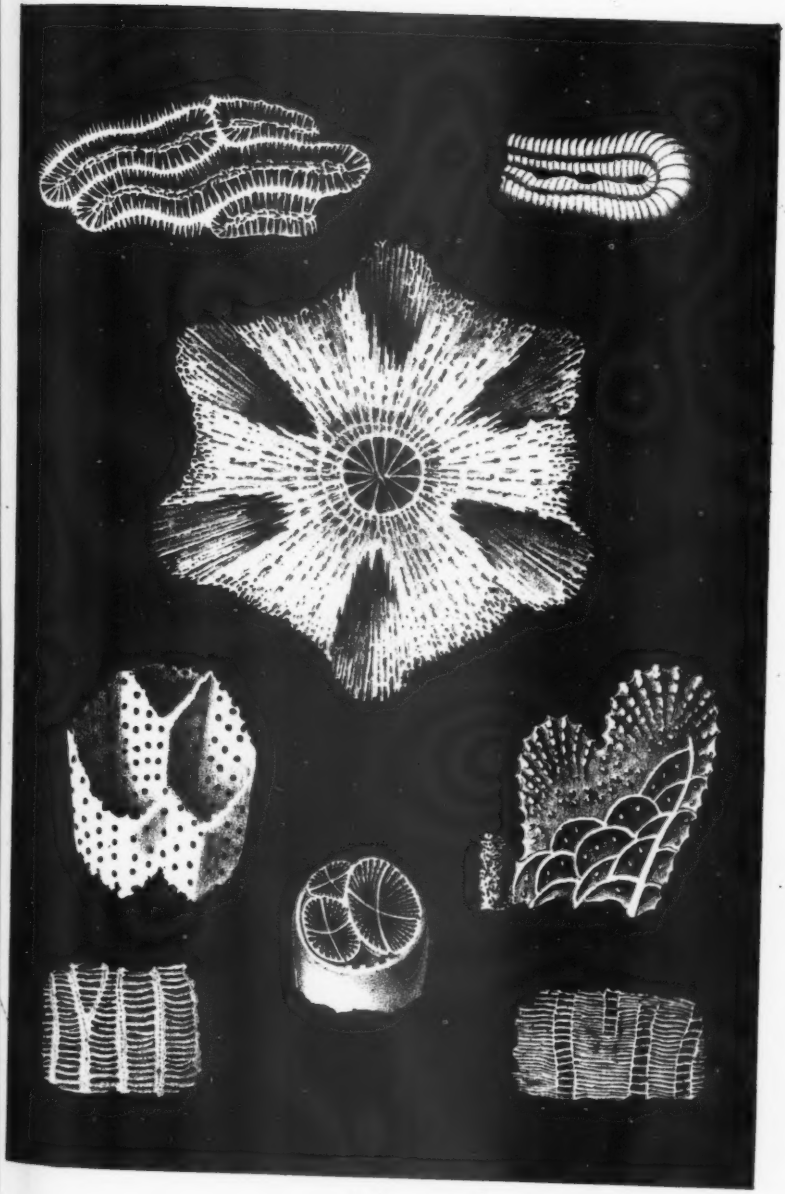
(*With a Plate.*)

PART III.

THERE is a wonderful diversity in the shape and contour of the tentacular discs of coral polypes, and it depends on the condition of the surrounding sea-water and on the characteristics of the hard structures of the calice. The colour of the oral projection, of the tentacules, and of the space between them and the mouth, differs in nearly every species; but it is always more brilliant when the nutrition of the polype is being carried on rapidly. Allusion has been made to the effect of too great stimulation upon the contractile tissues of the disc, and it will therefore be easily understood that a badly aerated medium and deficient food will alter the general appearance of the tentacular circle and the brilliancy of the colour spots of the tissues. Usually the general contour of the hard parts of the calice is a specific distinction; and although the individuals of some widely-distributed single corals, like the Caryophylliæ, occasionally present variations in the calicinal shape, still the restriction to a definite form is most common. Some calicular ends of simple corals are circular or elliptical, and others are very elongate, curved, and occasionally in the shape of the figure eight. Usually the margins of the calices are on the same plane, but in some genera, such as Flabellum, the long axis of the calice is on a lower plane than the short. The presence of a columella and pali influences the general appearance of the disc, for the first of these structures affects and limits the size of the visceral cavity, and produces a certain amount of prolongation of the stomach, and probably a greater capacity in the lips for protrusion. The pali are one or more circles of laminæ, which are attached internally to the columella, and which bear definite relations to the internal ends of certain septa. They spring from the base of the coral, and pass upwards generally to a higher level than the internal edge of the septa, and are firmly adherent to the columella, being, moreover, ornamented differently to the septal laminæ. In some cases they are quite distinct and separate from the internal edge of the septa, between which and the columella they are placed; but in most instances they adhere here and there to the septal edge, being free, however, at the bottom of the calice.

Sometimes the pali are twisted like a broad ribbon, when it is fixed below, and turned round by the hand above; and then their appearance, in connection with straight septa, is very elegant.

The columella arises in many species of corals from the inner base, and grows upwards with the septa and pali; it presents a great many varieties of structure, and the most striking are those where a simple conical spike-like body, or a greater or less number of ribbon-shaped processes, twisted and united, are seen. Such columellæ are termed "essential," and differ from those which are simply formed by endothecal growths from the ends of the septa. The columellæ afford a support to the internal ends of some of the septa when there are no pali, and in some corals constitute the bulk of the corallum. Usually they are of small size. The columellæ are of secondary importance in the generic diagnosis. Their shape and structure afford specific and often generic distinctions, and it is very remarkable that there should be, in every family of the stony corals, genera whose only differentiation is the existence of a columella. The relation of the pali to the septa will be noticed further on, but their connection with the shape of the disc is on account of a circle of tentacules rising up above them, and separating the oral projection from the marginal tentacules. When there are two circles of pali there are corresponding tentacules, but the mesenteries present no increase in size in consequence of this extra development of the polype's hard structure. An Australian tertiary species has well-developed pali, but there is no columella; and this is a good proof of the independence of the two structural elements. Moreover, this is also hinted at when there are two circles of pali, for then one set is in advance or external to the other, and quite separate from the columella. The pali are covered with and are produced by the tissues of the visceral cavity; they thus add to the extent of the general surface, and it is somewhat remarkable that when they exist, the dissepimental or endothecal structures are often deficient. Thus in the great genera Trochocyathus of the secondary and tertiary rocks, and Caryophyllia of the Cainozoic and Cretaceous, the pali are prominent and important structures; but there are no dissepiments, and the interseptal spaces are open from the disc to the base of the corallum. The shape of the disc is altered by the fissiparous division which peculiarizes many genera. This is brought about by two opposite septa growing across the middle line, joining and increasing in size. Then small septa are developed from the sides of these large ones, and finally the original



CORALS.

calice is divided. The large septa lose their septal characters, and become the wall between two contiguous calices, and the small ones receive mesenteries between them. A separate visceral cavity, mouth, and part of a set of tentacules must be formed in these fissiparous calices soon after the junction of the large septa; but how all this occurs has yet to be discovered. Either the contiguous calices separate after a slight upward growth, and again subdivide, or remain permanently adherent.

One of the greatest difficulties in the specific distinction of the Sclerodermic Zoantharia is the comprehension of the septal arrangement. A certain definite number of calcareous plates passes from the inside of the wall of the coral towards the centre; these plates are the septal laminæ, and two being closely united laterally, form a septum. As the coral grows other septa appear, and not in a confused manner, but according to a law of growth almost mathematical in its exactitude. After the hard tissues have grown so as to give the young coral some stability, the number of septa is generally found to be six. These are the primary septa, and between them are six interseptal spaces—loculi or mesenteric spaces, as they are called. As the corallum grows, six other septa appear; starting from the inside of the wall, midway between the primary septa, they produce a division of the mesentery into two parts, and cause the growth of new tentacules over them. These are the secondary septa, and when they are all fully developed the septal number becomes twelve—six primary and six secondary; and there are, of course, twelve interseptal loculi or mesenteric spaces. The septa thus appear in cycles. The six primary constitute the first, and the six secondary the second cycle. The spaces between the six primary septa are termed "systems," and when there are twelve septa developed, as just noticed, there are two cycles in six systems. If the septal growth still increases, rudimentary laminæ appear simultaneously in each of the spaces between the primary and secondary septa, and they rapidly become septa of the third order. One being found in each interseptal space, there are of necessity twelve of them, so that the whole number is increased to twenty-four; that is to say, six primary, six secondary, and twelve of the third order; and there are twenty-four interspaces. The twelve newly-formed septa are called the third cycle, and corals thus formed are said to have three cycles of septa in six systems. The further growth of septa is rather complicated, for the next set of them do not all appear at once as the third did, and consequently every interseptal space does not have a new septum developed in it. The

arrangement of the third cycle is as follows—the figures stand for the septa and the lines for the interseptal spaces:—

1—3—2—3—1—3—2—3—1—3—2—3.

These are the septa shown by figures of one-half of the calice, and they number 3 of 1, 3 of 2, and 6 of 3 = 12. Now the next septa originate between the primary and tertiary septa, and not between the second and tertiary. The septa of the fourth cycle will then first appear as—

1—4—3—2—3—4—1—4—3—2—3—4—1—4—3—2—3—4.

After a while the cycle is completed by the simultaneous appearance of septa of the fifth order between the second and third septa, and one system will then be thus enumerated—

1—4—3—5—2—5—3—4—1.

The total number is for four cycles in six systems—6 primary, 6 secondary, 12 tertiary, 12 of fourth order, 12 of fifth order = 48. The commonest cause of the perplexity in estimating the septal arrangement of species is from the abortion or non-appearance of some of the orders in the cycles: but by carefully determining which are the primary and secondary septa the difficulty can usually be surmounted. The primary septa are the longest when the septal number is not great, but when there are forty-eight, the secondary very often equal them in length; and when there are more septa, the tertiary have the dimensions of those anterior to them.

Now the pali have a most remarkable relation to the perfection of the cycles. When there are pali between the columella and the inner ends of the secondary septa, some pali may exist before one or more of the primary; but when there are pali before the third cycle (the tertiary septa), none are found before the primary unless every secondary septum has one in relation to it. So when the fourth cycle has pali before it, they invariably are also found before all the tertiary if there are examples of their presence in relation to the primary or secondary. Usually the pali are largest before the most recently-developed septa, and are produced after the early growth of the laminæ. The pali radiating from the axis of the coral constitute one or two "crowns," the second being more eccentric than the other. When there are two crowns, there are pali before all the cycles except the last, and there must be three cycles; whilst, if there are three crowns, there are inevitably four cycles of septa. In some rare instances there are pali before all the septa. These little complimentary septa (the pali) are thus developed according to a rule, and it is clear that unless all the septa of a cycle are present, some members of the previous cycle

are deficient in pali. The beauty of the calices of many stony corals is very great, and the elegance and symmetry of the septa, the one or more rows of pali, and of the papillæ of the central columella, are most remarkable.

There are many exceptions to the development of the septa in six systems, and pentameral, decemeral, and octomeral arrangements are peculiar to certain genera. But it is supposed that the abortion of certain septa produces the apparent pentameral and other schemes, and there is a capital example of such a deficiency of growth in an Antipathes which presents six tentacules, four being small and only two mesenteries, the rest not having grown to maturity. The Palæozoic genera of corals are generally supposed to be characterized by a quaternary arrangement of the septa, and to belong to a great section, called by MM. Milne Edwards and Jules Haime the Rugosa. This is true to a certain extent, and many genera resemble Stauria in the possession of four large primary septa. I have described *Montlivaltia radiata* from the zone of *Ammonites raricostatus* of the lower Lias, and it has the rugose septal peculiarity; and the well-known massive coral from the lower Greensand, *Holocystis elegans* is another example of the descent of the type beyond the oldest rocks. When the Rugosa are carefully examined, this quadrate arrangement turns out to be rather exceptional; and alternate development, the omission of one, three, or four large septa, and the eccentric radiation of the plates are quite as characteristic. In fact, the whole section is a dire puzzle to the student of palæozoic forms, and requires careful reconsideration.

There are plenty of genera of corals in the Palæozoic rocks which do not belong to the Rugosa, for the Tabulata are well represented. The study of the corals of the zones of *Ammonites angulatus* and *A. planorbis* of the lower Lias, proves that long after the species of the great Palæozoic age had died out, the types upon which many of the Liassic corals were formed clearly relate to the older forms. The genetic relation is evident, and the comparison of the species from the Sutton stone with those of St. Cassian in the Trias, affords ample evidence in favour of the descent by variation of many of the Liassic from the Palæozoic and Triassic forms.

The upper edge of the septa is either smooth in its gentle curve, or more or less dentate and spinose. These peculiarities were seized upon by MM. Milne Edwards and Jules Haime for the purposes of classification, and the smooth-edged species with endo-

theca were separated from those with ragged and dentate edges; the sub-families of Eusmilinæ and Astræinæ were thus differentiated. The structural distinction does not appear, however, to be very important, and the separation into the sub-families has been occasionally of very doubtful benefit. All the Montlivaltia were classified as Eusmilinæ, but it was soon discovered that many species had very elaborate dentation. Such species received another generic name until the progress of study determined that the Eusmilian characteristics were produced by the wear and tear of fossilization.

The septa project very differently in many genera. In the Mediterranean and Madeiran Desmophyllum the largest septa extend upwards in the form of large convex plates, and they even project externally; but in the Caryophylliæ they are much less prominent, and in the Stylophoræ the laminæ are often concave above, and do not present a prominence. The projection refers to the order of the septa; and the elegance of the calicular margin is often increased by the crenulation of its septa produced by different amounts of growth.

There are, however, many compound or aggregate genera, such as Stephanocœnia and Plesiastræa, that have abundance of endotheca and pali, and the genus *Asterosmilia* (nobis) includes some simple corals, resembling Trochocyathi, with pali and endotheca. It is very difficult to distinguish small pali from the ends of long septa; which unite with the columella, especially if they are at all dentate; but the study of transverse sections of the corallum will generally enable the point to be cleared up.

One of the causes of the elongate shape of the tentacular disc is a peculiar method of growth that characterizes many genera. Instead of the development of a regular and definite succession of mesenteric folds, and consequently of intermediate septa, and of the restriction of the calicular shape to a circular or elliptical outline, the corallum grows in one direction only: and the septa, instead of radiating from the columellary space, are parallel, and in a lengthened series. The calices of such serial corals are often very long, and may be curved from deformity, or from a special disposition to depart from the perfect straight line. They are rare amongst simple corals, but in the genus *Thysanus* (nobis) the elongate calice and the parallelism of the septa are well seen. The common brainstone coral, *Diploria cerebriformis*, has the elongate and curved calice in excess, and it is one of the best examples of serial aggregate corals. The ridges, with a shallow meandering trough between

them, are the united margins of contiguous calices, and the broader trough, with the more or less parallel septa, is the serial calice. In these serial corals the disc is continuous, until a definite boundary between successive lines of calices is formed by the hard parts; so that the soft tentacular margin may be some inches long, and only a few lines broad. The tentacules are always small in the serial discs, and close to the edge; and there are several oral openings, each with its lips, short œsophagus, stomach, and pylorus opening into a vast common visceral cavity. These calices may be very gyrate, and the tentacular arrangement follows the gyrations, and the mouths are always placed at regular intervals. Columellæ and pali are sometimes associated with serial calices; and if there are no pali there are usually very strong dentations upon, or else a lateral enlargement of the central ends of the largest septa.

The costæ may be considered, in a general sense, to be the continuation of the septa outwards and beyond the wall. They resemble the cogs of a wheel, the tire being the wall, the spokes the septa, and the axle the columella. In some Caryophylliæ and Turbinoliæ the continuity between the costæ and the exsert septa is very evident, and both of the structures are much higher than the upper margin of the wall. But it is very probable that this exsert condition of the septa and costæ is to be referred to the corallum having attained its full development as regards height. The further upward growth of the wall was then arrested, and only the combined costo-septal apparatus grew on, for when the costæ of the same specimens are broken off low down, it is evident that the wall intervened between their bases and those of the corresponding septa. It would appear that the costæ and septa are not developed by the same parts of the soft tissues, except when both are exsert and above the wall, and an occasional want of correspondence between the septa and costæ about to be mentioned is in consequence of this. It is probably quite correct to give the costæ an origin independent of the septa, and to assert that they are frequently separated by the thickness of the wall. The costæ are developed by the inner layer of the tissue which covers the outside of the corallum, and so are the exothecal structures and the outside of the wall. The costæ as a rule follow the cyclical development of the septa, and are called primary, secondary, etc. All the varieties of length, thickness, porosity, solidity, and ornamentation observed on the septa are represented in the costal structures. As a rule the costæ are shorter than the septa in transverse section, but there are many exceptions to it, for it is

common to find a very well-developed costa continuous with a rudimentary septum of a high order. The projection of the costæ from the wall and the size of the space between them—the intercostal space—vary greatly; in some species the costæ are close, and form simple prominent edges, whilst in others they are wide apart, project greatly, and may be covered with spines, wings, dentations, and granules. They do not always project at right angles from the wall, and their projection differs in the lower and upper part of the coral. Whatever may be their form and length, they have sides and a free surface. The sides are often spined and granulated, and are frequently joined to those of neighbouring costæ by the exotheca. The variety in the ornamentation of the different cycles of costæ in the same individual is very interesting, and its study is of great use as a secondary method of specific diagnosis.

In many compound corals the costæ of one corallite run into and join those of the neighbouring corallites, and in others where the walls become fused the costæ are only seen on the surface, or they may abort there as well as lower down. The genus Thamnastræa affords an example of the first condition, and Isastræa of the last. The contrary is, however, very common, and in such genera as Heliastræa the costæ are prominent on the surface of the great corallum, and where they are lost to the eye from the approximation of the numerous parallel corallites they still continue as projecting laminæ. The costæ are not invariably continuous with the septa, and there are examples in the Australian tertiary corals, the Liassic Montlivaltiæ, and in the Palæozoic Zaphrentidæ and Cyathophyllidæ, where the intercostal space is continuous with the external edge of the septum, and the space on the wall between the septa is carried externally into the form of a costa. In many species the epitheca, whilst covering the costæ and hiding them from view, appears to produce their partial absorption, for above the limit of the epithecal structures the costal ornamentation is elaborate and very distinct. The costæ may, however, retain all their beauty whilst covered with the membranous epitheca.

Exotheca.—There are structures between the costæ of some genera which resemble the dissepiments that extend between the septa, and in others they pass outside the costæ as well, and form a means of junction between corallites during the formation of a compound corallum. The simplest exothecal dissepiments are stretched horizontally across the intercostal spaces, they generally reach the edge of the larger costæ, and now and then hide the

smaller. They may be horizontal, or more or less inclined. The highest dissepiment, or that nearest the calice, bounds the lowest reflexion of the soft tissues, just as the highest endothecal dissepiments bound and form the base of the soft tissues of the visceral cavity. In some species there are dissepiments between the costæ very high up, and in others much lower down. The distance between the dissepiments, their arched or plane course, their vesicular character, and the presence of vertical laminæ dividing the spaces between the dissepiments into cells, are all seen to vary greatly in different species. The exotheca is very feebly developed in most simple corals, and it may be noticed as small fold-like elevations on the sides of the costæ; but of course these ill-developed dissepiments do not reflect the soft tissues, which are continued from the internal and external bases to the calicular margin.

When the exotheca grows in a very luxuriant manner in compound corals, the costæ generally abort, and the corallites become united by means of this external hard cellular tissue. In the Solenastrææ the exotheca forms cells between the small costæ and others on their free external surface. A large amount of vesicular tissue is produced, so that the corallite is embedded in a great amount of exotheca. Under such circumstances, the word cœnenchyma is used to distinguish the tissue external to the free margins of the costæ, and it becomes a very wonderful structure in the genus Baryastræa, by simulating the structure often noticed in united corallite walls; it is as dense and hard as ivory. In the Oculinidæ this cœnenchyma is enormously developed, but the fine cellular structure becomes filled up with carbonate of lime; and this occurs also in the huge-branching *Dendrophyllia ramea*. All the branching corals whose calices are wide apart are principally formed of cœnenchymal exotheca, and the costæ are only seen as markings more or less distinct on its surface.

The wall or theca gives support to the costæ externally and to the septa internally, and it can be seen in the most complicated corals between the costæ at the bottom of the intercostal spaces and between the septa, where it bounds externally the interseptal loculi. It determines the shape of the corallum, and its solidity. Moreover, the columella, endotheca, and exotheca are intimately connected with it. Usually the wall is a very prominent feature in the corallum; but it may become so united to exothecal structures or to the cœnenchyma, as to be undistinguishable from them. In some large corals, whose epitheca is strongly

developed, the wall is either rudimentary, absent, or becomes absorbed. In those forms where the wall is absent, the septal laminæ are kept together by an extraordinary development of the endotheca and exotheca. Some of the Liassic Montlivaltiæ and the Palæozoic Cyathophyllidæ afford examples of strong epithecate structures and deficient walls. Some simple corals have walls which are moderately stout superiorly, and excessively thick and hard inferiorly, so as to encroach on the visceral cavity. This filling up of the lower part of the corallites is observed in some compound corals. It is very evident that this is an attempt to reduce the depth of the visceral cavity, and that it compensates for the absence of endothecal dissepiments. Two series of shapes of the wall are noticed; one more or less horizontal, and the other ranging from a shallow cup to a long cylinder in shape. The square, polygonal, and compressed outlines of some walls are usually the result of pressure during the growth of neighbouring corallites. The horizontal wall produces disc-shaped corals; the septa arise from its upper and the costæ from its lower surface. In some species the under surface is concave, so that the cup-shape is seen reversed. The second and commonest form may be slightly horizontal at first, and with growth the edges may turn up and enclose the calicular cavity; then any height, width, and contortion may result. The turbinate, subturbinate, conical, conico-cylindrical, tubular, and other forms may thus arise.

The fusion of contiguous walls in some genera of compound corals is of course destructive of the costæ, exotheca, and cœnenchyma. The wall occasionally gives out processes, and is often marked by growth rings, constrictions, and ridges. It is rarely symmetrical, for most simple corals are curved, twisted, or more or less compressed, and this is equally true as regards the compound. The base of the wall is often attached to foreign substances, and may be broad, concave from rupture, or very delicate and pedunculate. The Fungidæ are separated from all other corals by the presence of structures like cross bars between the septa and costæ. The bars appear to be exaggerated septal papillæ which meet in the midst of the interseptal space. They are called synapticulæ, and they do not limit the downward extension of the mesenteries or the depth of the visceral cavities. In some genera they are so largely developed that the wall is nearly absent, and they alone hold the structures together. The distinction between an endothecal dissepiment and a synapticula is, that the first is elongate in some direction or other, and forms more or less of a partition, whilst the last is not elongate

and simply attaches the septa or costæ to each other. When transverse sections are made of many species of compound corals which have a large quantity of endotheca, the septa appear to be separated by concentric layers of cross bars or synapticulæ; but a longitudinal section reveals the obliquity of the endotheca, and proves its elongated growth. In the genus Astræa there are dissepiments as well as synapticulæ, yet the corals have no strong affinities with the Fungidæ. The description just given of the hard parts refers to the section of the Aporose sclerodermic Zoantharia, and it is characterized by the imperforate condition of the wall and septa. In the genus Cyphastraæa the wall is stout, and the cœnenchyma is abundant, but the first step is made towards the section Perforata by the reticulate character of the septal laminæ. The septa in fact are perforate, and their ultimate fibres instead of being closely adherent are wide apart. In microscopic sections of all septa the porosity may generally be made out, and it is clear that the perforate character is an exaggeration of the normal condition. Such genera as Porites have corallites, septa, pali, and columellæ, but all the tissues are, as it were spongy, and the septa are represented by an elongated series of calcareous spicules. The soft tissues of neighbouring corallites must then be in intimate connection, and the details of their anatomy must be very different to those of the aggregated Aporosa. The great genus Madrepora shows a less reticulate structure than the Porites, and the branching stems of its species are often comparatively solid, but the most superficial examination will determine that they are not Aporosa. In the fossil Litharæa the cœnenchyma is scarcely and the septa are enormously developed, and the columella fills up the greater part of the centre of the calicular cavity. The Alvæporæ, on the contrary, have their walls in close contact, the corallites being pentangular in outline, and the septa are represented by long lines of spicules. In estimating the succession of structures in a zoological sense, the first step in the formation of a sclerenchyma would appear to commence in the sclerites of the Alcyonides, to pass on to the tubular dermoid secretion of the Tubiporæ, to branch off to the sclerobasic Gorgonides and Antipatharia, and to reach the Aporosa through the Perforata. But the direct genetic relation of such a series is most improbable, and the Perforata may have descended from the Aporosa.

The section of tabulate Madreporaria contains some genera which flourished in Silurian times, and others which with the Porites and Madrepores form the bulk of the present Pacific reefs, the persistence of form being very great especially in the Milleporidæ. These

corals are composed of distant and more or less parallel corallites, separated by a cellular cœnenchyma. The corallites are tall and slender, and have tabulæ reaching across their tubes, and completely shutting off the space beneath them and the calice. A columella which does not usually reach from the base, but which springs from the tabulæ is occasionally seen. In the Axoporæ this structure is the most important part of the coral, being formed of a fasciculus of rods, the tabulæ closing in the space between it and the corallite sides. The septa are well developed in some genera, as, for instance, in Lyellia and Columnaria, and the tabulæ clearly spring from them, and do not interfere with their continuity; but in others the septal laminæ are reduced to spicules or to faint projections from the wall. It is to be hoped that the researches of Agassiz on the Tabulata will be carefully followed, for the affinities of the section are with the true Madreporaria, and it is indeed anomalous to have a Hydrozoan with a dense calcareous corallum which has columellæ, septa, and successive chambers. Nevertheless nature is infinitely more fertile in entities than the human mind is in imaginations, and the dictum of the great naturalist is not to be passed over without serious consideration. The gemmation of corals and the manner in which their different shapes are produced, will form the subject of the concluding part of this essay.

DESCRIPTION OF PLATE.

The large figure just above the centre of the plate, is a porose or perforate coral, *Madrepora abrotanoides*. The parent corallite is central.

Above and on the right-hand side is a sketch of the disc, tentacules, and oral openings of a serial calice; and on the left-hand side is a group of serial calices of *Mœandrina*.

Below and to the right-hand is a diagram of the manner in which the endotheca, exotheca, and wall are related to the septa.

The rounded eminences with spinules upon them are the top of a septum seen in longitudinal section. Their outer continuation running downwards and parallel with a long white line (the wall), is a longitudinal view of a costa. From the wall at right angles pass, externally, the exothecal dissepiments, and internally in curved series and over the sides of the septa, pass the endothecal dissepiments. The columella is seen at the inner edge of the innermost dissepiment. The living polype inhabits the space above the uppermost dissepiments.

On the left is a magnified view of a perforate coral, showing the porose walls.

Immediately beneath these are views of tabulate corals; the right-hand specimen has cœnenchyma between the corallites.

The drawing beneath the Madrepora represents a rugose coral of the Palæozoic age.

THE MOHAMMEDAN HISTORY OF EGYPT.

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CHAPTER I.

EARLY AND LEGENDARY HISTORY TO THE TIME OF THE MOHAMMEDAN INVASION.

Egypt is pre-eminently the country of antiquity. To the European and Oriental mind alike, the sacred associations and traditions that linger in its soil must ever be fraught with profound interest and awe. To the Arab it is especially enchanting, for the contrast which its well-watered fertile vale presents to his own barren and sunstricken plains, and accordingly we find Mohammedan legends abounding in allusions to the country of the mysterious Nile. In the Coran mention is made of Egypt no less than thirty times, either distinctly or by implication, and various traditional sayings reported of the Prophet indicate the favour with which he regarded the land and its inhabitants. "Whoever would look on Paradise," said he, "or on its earthly semblance, should see the land of Egypt when its fruits are in bloom, and its cornfields green." And again, "at the creation of Adam, God foreshadowed to him all the kingdoms of the world, and when he looked on Egypt, and saw a river meandering through its plains, whose source was in Paradise itself, and saw its mountain sides all clad with verdure and with flowers, and knew that the favour of the Lord overshadowed it, and that His mercy watered it, then did our first father pray for the Nile and for the land of Egypt, and call down blessings on it seven times." A special blessing is also supposed to rest on it from the words attributed to the Patriarch Joseph, who, when brought to Egypt by Potiphar's servants said, "Oh Lord, I am a stranger, make this land beloved of strangers ever more." This prayer being accepted, no one ever touches its shores without

longing to make his abode there. Ahnás, in Upper Egypt, is the traditional site of the flight of the Holy Family, from the tyranny of the murderous Herod, and the neighbouring Bedawín, still believe that no locust can ever approach the land where the robes of *Sittná Miryam*, our Lady Mary, have swept along.

The first colonist of Egypt was Seth, the son of Adam, whose descendant Enoch (or Hermes or Edrís, as he is sometimes called) taught religion, and introduced several arts and sciences till then unknown. Before his time the inundation of the Nile took place both in and out of season, compelling the inhabitants to take refuge in the higher ground until the waters subsided. Hermes, however, taking the people with him ascended to the first cataract, and by carefully adjusting the levels of the soil, restored the balance of land and water, and confined the river within its present bed. Proceeding afterwards through Nubia and Ethiopia, he, with the assistance of the natives and of his own astrological skill, conducted the waters in a single channel, instead of allowing them to spread at random over the face of the country. Egypt was also the scene of this prophet's translation, or as some say of his decease.

After Enoch the country was governed by thirty-four Pharaohs, of whom the Pharaoh of Moses was the most wicked and godless. He is described by the Mohammedan authorities as of exceedingly dwarfish stature, his height being only six spans, whilst his beard was a span longer than himself. Of the Pharaohs who ruled Egypt seven were magicians—1st. Seilam, the first who invented a Nilometer. This was a magical contrivance, consisting of a copper tank, containing a little water, and guarded by two eagles, male and female. On the first day of the month, in which the Nile commences to rise, the King used to assemble the soothsayers and magicians who chanted their spells over the tank, when one of the eagles would turn yellow. If the male bird changed colour, the Nile would be high; if the female, the inundation was but slight, and the crops bad. 2nd. ʿAshámish, who by his magical arts devised a balance which he set up in the temple of the Sun, at Heliopolis. On one of the scales was written the word "Truth," and on the other "Falsehood," and beneath were arranged a series of weights. Now, whenever an oppressor and his victim came to the temple to settle their dispute, they each took up one of the weights, and having stated their cause, put them into opposite scales, and the weight of him who had committed the injustice was at once borne down by that of the person wronged. The third magician made a metallic mirror which revealed all the four quarters

of the earth at once, and indicated which spots were barren and which fertile. He also constructed a statue representing a young female seated on a rock in the attitude of nursing an infant. Any woman suffering from a disease had only to touch the part of the figure corresponding to the part afflicted, and obtained instant relief. The fourth invented a marvellous tree with branches of iron furnished with sharp hooks, and any evil doer who approached it was immediately seized by these, and detained until he had confessed his crime. He fashioned also a statue which he named 'Abd Zohul (the servant of Saturn), and which possessed such wonderful properties that any malefactor who came within its influence was at once rooted to the spot, and held there until he had made full confession of his crime, though he might refuse to do so for years. The fifth sorcerer made a tree of copper, which seized upon every wild beast that came near it, and deprived it of motion, so that it might be easily captured. In the reign of this Pharaoh, there was no lack of meat in Egypt. He moreover placed two statues at the gate of the capital, one on the right and the other on the left. Whenever a good man entered the city, the figure on the right hand smiled; but if a bad man entered, that on the left hand would weep. The sixth sorcerer made a dirhem (drachma), the weight of which would always counterbalance any amount of merchandise which its owner might wish to purchase; so that by bargaining beforehand that the goods should be sold by this weight, the possessor of the magic dirhem was enabled to defraud the trader to any extent that he pleased. This dirhem is said to have been discovered among the buried treasures of the Pharaoh's in the time of the Ommiade Caliphs.

The seventh magician after working many wonders disappeared suddenly, and absented himself for a long time from his anxious subjects. At last they saw him again in the form of the sun, in the sign Aries, when he informed them that he should never return to earth, and appointed a certain one as his successor.

The Pharaoh who persecuted the children of Israel was named Walíd Ebn Masáb, and according to some accounts was originally a bankrupt chemist from Persia, who having contracted large debts which he was unable to pay, fled to Egypt, where by a stratagem he gained the confidence of the reigning Pharaoh, and became his prime minister. Giving himself out as a necromancer, he spent most of his time in performing incantations amongst the tombs, by which means he attracted the attention of the king, whom he ultimately succeeded on the throne. Under his rule, which was very just and vigorous, and protracted to a miraculous length, the power

and resources of the country were immensely increased. But his unusual longevity, wisdom, and authority so infatuated him with pride that he rebelled against God, and claimed divine honours, thus bringing down upon himself those dreadful judgments which afterwards overtook him and his people, who had flattered and supported him in his impious and preposterous pretensions.

When Moses appeared and announced his mission from the one true God, Pharaoh only waxed more perverse, and ordered a huge tower to be built (the stones being for the first time set with mortar, of which he was the inventor), with the ostensible object of ascending to heaven and defying the God of Moses. Having completed the work, and mounted to the top of the tower, which had reached an immense height, he shot an arrow upwards into the sky, and this arrow falling again at his feet covered with blood, hastened his destruction by confirming him in his folly and pride. But notwithstanding all this, his administration of the kingdom is allowed by all the Muslim historians to have been strictly sound and equitable. They relate that his vizier Haman, being employed to construct the Serdús canal was solicited by the people of the neighbouring villages to bring the waters up to their doors; this he did on consideration of receiving a bribe from each district, and thus rendered the canal the most tortuous one in the kingdom. When these facts were made known to Pharaoh, he compelled his vizier to disgorge the bribes he had received, and severely reproved him for his cupidity. The revenue of Egypt in his reign is said to have been upwards of seventy-two million dinars annually. Of this sum Pharaoh retained a fourth for his own use and the expenses of his court; a fourth was employed in strengthening the military defences of the country; and a fourth in improving the land and constructing and repairing the bridges, canals, etc. The remaining quarter was buried; each village receiving back for that purpose a sum proportionate to the amount of tax levied from it, and the amount so disposed of was allowed to accumulate from year to year, until some pressing need or severe calamity should overtake the district. Every year, at the conclusion of the seed-time, he appointed two commissioners to travel through the country and inspect the farms. Each of these officers took with him a bushel of wheat, and if he found a piece of uncultivated ground sufficiently large to contain the bushel of corn, he sowed it therein, and reported the case to Pharaoh, when the negligent owner of the land was at once beheaded. So great was the fertility of Egypt at this time, and so strict the system by which cultivation was enforced, that it is said,

the commissioners frequently returned without having found a spot in which to dispose of their measures of grain.

The scene of Pharaoh's final catastrophe was at Wády Gharandel, about three days' journey from Suez, on the road to Sinai; the Red Sea being divided into twelve parts for the passage of the tribes. The Bedouín of the peninsula of Sinai have a tradition that Pharaoh's unquiet spirit still haunts the deep, and that the hot springs which exist a little lower down the coast, and are still called Hammám Farʿún (Pharaoh's hot bath), were caused by his angry drowning gasp.

When the children of Israel had passed the Red Sea, they at once lost their way, and were unable to proceed onwards to the Mountain of the Law. The cause of this was revealed to Moses, namely—their having neglected to fulfil Joseph's dying request, that they would carry his bones with them to the promised land. For some time no one could be found to tell where the Patriarch had been laid, but at last an old blind woman conducted them back to Egypt, and they brought away the embalmed body, which had been buried in the bed of the Nile, and carried it with them during their wanderings, until they laid it in the sepulchre of his fathers.

After the death of Pharaoh and his host, their remained not a single adult of the nobles of Egypt, and the government accordingly devolved upon a female named Delookah. This queen ruled with great ability and discretion, and fortified the country against hostile invasion by surrounding it with a mighty wall, with a moat behind it, and forts at intervals of three miles; vestiges of which may still be seen in Upper Egypt, where they have received the name of *Gisr el Agooz*, "the old woman's dyke wall."

After the death of Delookah, Egypt was again governed by men for four hundred years, until the time of Nebuchadnezzar, who conquered and devastated Egypt after his successful expedition against the Jews. From this period Egypt ceased to be an independent state, and remained a subject of contention between the rival powers of Greece and Persia, until the final overthrow of the latter power, when it fell entirely under the dominion of the Byzantine Emperor, Heraclius.

Macocas, the governor sent by this monarch, remained in command of the province for thirteen years, until the invasion of Egypt by the Mussulmans, in the year 638, under ʿAmer ibn "As, a general of the Caliph ʿOmar ibn el Khattáb. When, after a siege of three months, there seemed no longer any hope of holding out, Macocas, who was then at the Casr es Shamaʿ on the Nile, embarked secretly

on a barge which he had in waiting, and fled to Alexandria, leaving the castle to its fate. They say that the governor had already received miraculous intimation of the futility of resistance, through an adventure which befel him some time before at Alexandria. In this town was a certain door, having on it twenty-four locks, and when Macocas, coveting the treasures which he supposed it to conceal, announced his intention of breaking open the door, he was implored by the monks and priests who had charge of it not to yield to the temptation of avarice, but rather to follow the example of the kings and governors who had preceded him, and set an additional lock upon the door; they even promised to compensate him for his disappointment by themselves providing the amount of treasure which he expected to find within. This, however, only served to inflame his cupidity the more, and disregarding alike their warnings and prayers, he entered the mysterious chamber; but within, instead of the immense treasure he had hoped to win, he found nothing but the figured representation of armed Arabs, painted on the walls, and an inscription prophesying the conquest of the country by the Mohammedans in that very year.

Having raised the siege of the Casr es Shama', 'Amer ibn As proceeded to Alexandria in pursuit of Macocas, and made overtures of capitulation; these were refused, and 'Amer and his troops having shortly afterwards gained admission to the city through the treachery of one of the gate-keepers, obtained undisputed mastery of the country, and led the ex-governor into captivity.

On his return to Casr es Shama' he founded the city of Fustát, now known as Masr el 'Atíkah or Old Cairo, which remained the metropolis of Egypt until the foundation of the present Cairo, by Goher, a general of El Moézz or Abu Temím, the first of the Fatemite dynasty, who ruled Egypt. The name Fustát, which signifies "a goat's hair tent," was given to the city from a singular circumstance which led to the selection of the site. When 'Amer ibn "As had raised the siege of the Casr es Shama', and had given orders for the removal of his camp, previous to his pursuit of Macocas, it was discovered that a turtle dove had built its nest in the roof of his own tent (Fustát), and was there rearing its young. 'Amer being a man of a gentle disposition, was unwilling to disturb the bird, and commanded that his tent should be suffered to remain where it was. Returning from his conquest of Alexandria, he ordered his officers to pitch the camp at the place where his Fustát had been left, and that name continued to be applied to the spot and to the city which he afterwards erected thereon. 'Amer ibn

el 'As governed Egypt as viceroy of the Caliph 'Omar, until the death of that prince, by whose successor, 'Othmán, he was removed to Medínah, and superseded by 'Abdallah ibn Abi Sarh. The rule of the latter was so oppressive, that in the reign of the Caliph Muáwiyeh, 'Amer ibn 'As was recalled to Egypt, and held the reins of government as viceroy until his death in the year 664 of the Hijrah.

STEIN ON THE STENTORS.

(*Continued from* p. 423, Vol. III.)

THE *Stentor Roesellii* is described by Stein as "having a body which reaches large dimensions; when fully outstretched scarcely a quarter as broad at the fore-end as it is long: always colourless; nucleus, a meandering undivided band: the creature often moored to the bottom of a gelatinous case." Ehrenberg named the colourless Stentors with a riband-shaped nucleus *S. Roesellii*, and those with beaded nuclei *S. Mülleri*.

Some observers have regarded *S. Mülleri* as a variety of *polymorphus*, and even *S. Roesellii*, as the nucleus of *polymorphus* takes the riband form during the process of fission. Stein, however, does not take this view.

S. Roesellii he has found more than other Stentors living in a gelatinous tube, as shown in Plate II.,* Figs. 1 and 2, but he has not unfrequently observed it on damaged leaves of *Lemna trisulca*, which had lost their epidermis and had become rusty yellow, without its tube, inserting its nether end in the intercellular space of the leaf, and retreating into it for shelter at the slightest movement. The tubes are not—he says—as a rule attached to foreign bodies, but suspended either singly, or in a heap of several together, from the dirty surface of the water. The tubes are composed of a soft amorphous transparent colourless substance, in which small molecules are embedded, sometimes aggregated into fine threads (Plate II., Fig. 1, *h*.). They also contain siliceous particles, diatoms, etc. Usually these tubes are sack-shaped, rounded and widened at their base, and rather narrower and bent inwards at the top.

When the creature retreats into its tube the upper margin is

* Opposite p. 417.

frequently pulled together and closed. The dimensions of the tube vary considerably, reaching at most half the length of the outstretched animal, and often not more than a third or a quarter of it. The width does not vary much in individuals of the same size, but two creatures are sometimes found in very wide tubes, one of them keeping inside while the other was suspended and seeking for food. In these cases it did not appear that the original inhabitant had suffered longitudinal division, but a free-swimmer had backed into the tube and found it a welcome asylum. Stein has frequently noticed this process, and seen the intruder fix himself in the tube, his point of attachment lying a little on one side, and above the base as shown, Plate II., Fig. 2. The method of attachment is easily observed, in consequence of the transparency of the tube. It is not accomplished by means of a sucker, for the hind part of the body has a different structure, and is not immediately attached to the tube. It commonly ends in a blunt conical wart, furnished with a row of fine threads which anchors the animal to the cell, and on which it swings (Fig. 2). Sometimes the terminal wart is two-lipped, but the attachment is still made by means of the threads.

In fully outstretched specimens the body is narrower than in *polymorphus* and *cæruleus*, and large individuals reach a length of $\frac{1}{2}'''$.

Plate II., Fig. 3, *e*, exhibits several embryo cells in a *Stentor Roesellii*, and on the other side developed embryos may be seen. Another embryo has left the mother and adheres to her by its tentacles near the top of her body on the left. Stein represents the embryo cell as giving rise to daughter cells, as may be seen in the plate. He says the embryo cells behave like vorticellæ. Sometimes they are round, then rounded triangular or square, very clear, transparent colourless homogeneous balls, reaching a diameter of 1—40‴. They exhibit near the surface one or two small lively pulsating contractile vesicles, and in their centres a roundish molecular nucleus about 1—70‴ in diameter. The daughter cells arise from a combination of budding and fission. The nucleus of the mother cell pushes forth a little projection which increases quickly, and in time a portion of the colourless cell matter surrounds it and it becomes the daughter cell, which first appears as an ovalish body lying across the mother cell, as shown in Plate II., Fig. 4, *a*. It possesses at this period a contractile vesicle, which is never on the same side as that of the embryo cell. Fig. 4, *b*, represents another stage of the daughter cell's growth, and in the next stage *c*, the

nucleus portion of the mother cell is separated, and forms a distinct nucleus of the daughter cell. In this figure the cilia which grow from the free end of the daughter cell are likewise shown, and from the lower end the tentacles sprout, commencing as minute buds. Fig. 9, *a*, *b*, *c*, show the embryos in a developed state, and about 1—63‴ in length, the tentacles are retractile, and may be seen stretched out and forming an elegant coronet of rays. The nucleus is round and situated at the hinder part of the body, and in front of it two, or only one contractile vesicle. These embryos can swim with either end foremost, and move with moderate celerity. The young Stentors nourish themselves for a short time with the juices of other infusoria, which they extract by means of their tentacles, and then by a simple metamorphosis they assume the mother form, as shown in Fig. 6, A and B.

Stein figures some specimens of *S. Roeselii*, in which the nucleus presented peculiar appearances. In Plate VII., Fig. 7, of his work, the nucleus is a broad body, with a round swollen head, another oval swelling below the former, and a slight one at the lower extremity. This nucleus is bent so as roughly to resemble the letter S; it is much wider than in the normal condition, and full of pointed, oval bodies, not unlike some of the boat-shaped diatoms in appearance. In Plate VIII., Fig. 13, the nucleus seems to have been divided into three masses, one large and globular, flattened on the inner side; a second smaller, but somewhat similar; and the third round at the top, then constricted, and after that swelling out into an oval smaller than the ball at the top. These masses are filled with the "little spindles," as Stein calls them. Fig. 14, in the same plate, represents a similar mass, which he broke by compression and squeezed out of the animal. It discharged a great quantity of the small spindle-shaped bodies and molecular particles. He describes the former as "sharply defined, dark bordered, rigid, colourless, transparent, short, little spindles, 1—570‴ to 1—380‴ in length, and not endowed with any proper motion. Some time ago, Stein took these bodies for spermatozoa, but he now says this notion must fall to the ground, as Stentors in conjugation have their nuclei in the usual state. There are, he considers, two suppositions to be made: either the spindle-form bodies are the results of fatty degeneration of the nucleus, or they are parasitic organisms.

The *Stentor igneus* Stein thus describes: "Body of moderate or small size, nearly twice as long as wide, coloured bright green by a rich supply of chlorophyl globules, outside which is a finely divided red pigment embedded in a colourless parenchyma, which

is usually most strongly developed in the circumference of the peristome, but is sometimes entirely wanting; the nucleus a simple round body." He observes that *S. igneus* has most resemblance to *S. niger*, and often taken for it. Ehrenberg mixed both together, and depicted them as *S. niger*, and did not figure *S. igneus* because his plates were finished before he saw the propriety of their separation. All specimens of *S. igneus* seen by Stein were free-swimmers, turning all the while upon their axes. The bodies of these creatures are usually from 2 to 2½ times as long as wide, and bent inwards on the left-hand side. When fully outstretched they are sometimes thrice as long as they are wide, and either widened or narrowed at the peristome end. When contracted they are oval or globular. Large specimens reach 1—6‴ in length, and from 1—16‴ to 1—12‴ in breadth. Single individuals Stein has found 1—5‴ long and about one-third that breadth, and the smallest he observed were lop-shaped, 1—14‴ long and 1—20‴ broad. They do not vary much in shape when swimming in abundance of water, and alter very gradually when they do change; but in a small supply of water they contract themselves to a globular form, and often remain stationary and indolent. Sudden energetic contractions he has never witnessed. Their body-tissue resembles that of the green varieties of *S. polymorphus*, but is tougher. They do not suffer diffluence for want of water, and some pressure of the covering glass is required to break them up. The chlorophyl globules are so thickly diffused as scarcely to leave any interspaces, and they occupy the inner layer of the parenchyma under the stripe system. The stripes are colourless, like those of *S. polymorphus*, but with this difference, that in most cases they have embedded in them more or less numerous pigment globules, commonly blood-red, but often lilac or cinnamon coloured. They are very different from the blue pigment masses of *S. cæruleus*, as the latter give a general blue tint, while those of *S. igneus* are more distinctly separate, and look like small oil drops. These pigment bodies are often thickly sown in the fore part of the creature, and within the peristome margin. Stein's figure shows below the peristome of one of these stentors a row of elongated, triangular patches, composed of small pigment cells, which, he states, are red. The nucleus is usually of a simple globular, short oval, or rounded triangular shape, situate in the middle of the body, a little backwards. It is of a homogeneous substance, but occasionally contains isolated, thick globules. Its dimensions ordinarily are 1—63‴ to 1—54‴, and in young ones 1—96‴ to 1—76‴.

Amongst the individuals with a simple nucleus, it is common to find some with two or three globular bodies distributed irregularly through the parenchyma, which Stein regards as germ-cells. [In June, 1861, he found individuals with two of these bodies, 1—54‴ to 1—48‴ in diameter, containing opaque central nuclei, and by using acetic acid he succeeded in raising up a delicate membrane which enveloped them, and in October of the same year he found one richly supplied with the red pigment, and with a well-developed embryo cell lying below the nucleus.

The nucleus is the chief distinction between *S. igneus* and *S. polymorphus*, and the rarity of fission is also to be noticed. When he succeeded in observing the first stage of this process, the new peristome was formed at a considerable distance below the old one.

Stentor niger is thus described: body of middle size, very changeable in form: when fully outstretched nearly three times as long as broad; the body tissue equably coloured reddish yellow, or dark copper brown; the neucleus a simple round body. *S. niger*, he says, is naturally larger than *S. igneus*, and always much broader. It reaches almost the ordinary dimensions of *S. cœruleus*, which it resembles in the nature of its parenchyma and general form. Fully outstretched individuals are not seldom 1—4‴ long, and about one third as broad. The hinder part of the body is stiff and style-shaped, and gradually growing funnel-shaped towards the front. The body tissue is as soft as that of *S. cœruleus;* the creatures assume all shapes, passing quickly from one form to another, thus differing from *S. igneus*. The colouring of the body affords another distinction, which is a uniform dirty reddish yellow, or dusky copper brown; but some young ones are almost colourless. The colour looks darker by transmitted than by reflected light. Under the latter large specimens often look greenish yellow. As in *S. igneus*, the pigment consists of minute particles, but they are distributed through the entire substance of the stripes, and only near the oval wreath are brown or greenish yellow oil globules, irregularly and sparsely distributed. In contracted specimens the cross stripes are seen nearly as possible as in *S. cœruleus*.

In this species, Stein has frequently noticed fission to take place, but only once did he witness conjugation between two individuals in lateral contact, and with their peristome-fields in union. When the individual on the left turned his ventral side fully towards him, the right hand one showed his left side, and just beyond the middle of his back. It covered with the middle ventral part of its peristome-field the left upper margin of the other

one's peristome-field. The mouths of both were uncovered, so that food could find its usual entrance. Stein thinks the Stentor which Strethill Wright found in the Edinburgh Botanical Gardens, occupying a gelatinous tube, and which he named *Salpistes castaneus*, belonged to the *S. niger* species.

Stentor multiformis Stein describes as having a body of the smallest size: very changeable in shape; the substance of the body stripes, a uniform intense blue, or sea-green; neucleus, simple and round. It is a marine species. Fully-developed individuals, when stretched out, are scarcely 1—8‴ long, and about one quarter as wide. The commonest size is between 1—15‴ and 1—20‴ long, and two or three times as broad. When quite young, scarcely 1—24‴ long, and half that breadth. This species was discovered by O. F. Müller, and closely resembles *S. polymorphus*.

NEW ELECTRICAL FIGURES.

The "Archives des Sciences" for July, gives the following account of a paper in "Poggendorf's Annalen," t. cxxxvi. p. 612.

The employment of fine dust, which has rendered great service in acoustics, in enabling us to exhibit those regular movements of small amplitude which are produced on the surface of vibrating bodies, has found its way into experimental electricity, and has served in certain cases to demonstrate the distribution of electricity or magnetism on the surface of bodies. M. Kundt has applied this method to the study of electrical discharges between metallic conductors. He has found that when an electric discharge takes place between a horizontal plate of metal powdered over with lycopodium, forming the positive pole and a ball or point placed immediately below it, the dust remains attached to the plate on a well determined circular area, outside which it may be easily driven off by blowing upon it. What remains in the circular space is evidently attracted by a residuum of electricity.

If the metal plate powdered with lycopodium is made the negative electrode, it is difficult to make the experiment succeed.

The dimensions of the figures obtained in this way vary under certain conditions, such as the shape and distance of the negative electrode. M. Kundt has observed its diameter to range from $10^{mm.}$ to $200^{mm.}$, but when the conditions of the experiment

remain the same the appearances are very constant, and admit of precise measurements.

With a ball $50^{mm.}$ in diameter for a negative pole, he obtained a small circular figure, badly defined, with a diameter of from $10^{mm.}$ to $20^{mm.}$, with a negative ball $20^{mm.}$ in diameter, the figures became a regular circle, with sharp outlines, and $50^{mm.}$ in diameter. When the plate, positively electrified, was discharged by means of a point more or less fine, so that no spark was produced, there remained after the superfluous dust was blown away a circular figure perfectly regular; and with a diameter increasing in size in proportion as the point was made sharp. When the plate was charged negatively, the circular figures could only be obtained by the aid of a very fine point, and by effecting the discharge without a spark. Without these precautions no dust remained attached to the plate.

The figures may be produced in an inverse way, by making a negative conductor approach the powdered plate, and allowing the discharge to take place without a spark.

The experiment may also be made with a Leyden plate; but it is best to make a communication between the two sides of a Leyden jar, on one side with a simple metallic plate, and on the other, with a point or ball held above it, so that its distance can be regulated at will.

We have already seen that the dimensions of the lycopodium figure increase as the diameter of the spherical conductor situated above it is diminished, and that it reaches its maximum when the conductor is a fine point, and the size of the figure is also augmented as we increase the distance between the point and the plate.

Lycopodium powder is best adapted to these experiments; but we can employ non-conducting substances, such as sulphur or resin. With good conductors, such as carbon or steel-filings, we observe a whirlwind of dust during the passage of the current, the particles of which rise up and tend to congregate round the negative point, but they are not observed at the close of the discharge.

M. Kundt explains the production of these circular figures by supposing that the non-conducting dust continues charged with electricity, after the plate has become neutral by discharge, and is thus able to adhere. The circular form shows that the discharge takes place in a regular cone.

WOMANKIND:

IN ALL AGES OF WESTERN EUROPE.

BY THOMAS WRIGHT, F.S.A.

CHAPTER XVII.

THE MOVEMENT OF THE SIXTEENTH CENTURY IN FRANCE.

During the sixteenth century the tone of society in France was gradually passing through a great change. To this change many causes had been for a long period contributing. All that remained of the Middle Ages was the spirit of pride and ostentation, of extravagant display and of costly enjoyment, already mentioned, which had been increasing during the fifteenth century. The expenses of a man of any mark in the world, and especially of those who claimed a place at court or in fashionable society, were usually much greater than his income. The extravagance of the dress of either sex, was something we can hardly now conceive; and it was said proverbially that the nobleman, and often the gentleman, too, carried all his income on his back. This state of things lasted through the whole century, and into that which followed. The reader will call to mind the story of his own troubles at the beginning of the latter period told by the Maréchal de Bassompierre in his *Memoires*. He was engaged to a ballet at Court, and one article only of his dress consisted of a coat of cloth of gold, ornamented with palm-branches, and laden with pearls to the weight of at least fifty pounds. The cost of this dress was estimated at fourteen thousand écus, of which seven hundred were reckoned for the making. When he applied to his tailor, the latter required earnest-money to the amount of four thousand écus, before he would begin the work. This, too, was a very large sum of money in those days, and Bassompierre knew not how to obtain it. But in the midst of this difficulty, the Maréchal was invited to sup with the Duke d'Epernon, and after supper, as was then usual in high society, the evening was spent in gambling, and they played high. Fortune took compassion on the Maréchal, and though he possessed no more than seven hundred écus when he began, before the evening was over he had increased them to five thousand. Next morning he paid the earnest-money for his dress, and fortune continued to favour him during several following days; before the evening of the Court ballet, Bassompierre had won seventeen thousand écus, which enabled him

to pay the whole of his dress, including a magnificent sword enriched with diamonds. Such was fashionable life early in the seventeenth century, after the recklessness of the sixteenth century had been already greatly curbed by the policy of Henri IV.

The anecdote just related depicts a state of society in which morality must have stood very low. Men of rank, fortune, and personal distinction, who after squandering away their income in extravagance, could depend upon gambling to supply their wants, would have little hesitation in supplying themselves with money in almost any other way, and we unfortunately find in studying the social history of the time, that this was too generally the case. In fact, since the end of the fourteenth century, or in other words, since the fall of feudalism, the life of the aristocracy in France had been one simply of selfishness, and the ambition that of obtaining money for self-gratification in one form or other. Places and dignities were sought as so many means of enabling those who obtained them to share in the money of the public. In fact, the crown itself was valued by its holder chiefly for the same reason, and because it gave a power of extortion and compulsion. The first idea of a noble or of a gentleman, when he wanted money, was to borrow, but there was soon a limit to borrowing, and nearly all the representatives of the old feudalism were overwhelmed with debts. The salaries derived from public honours and places were soon wasted. Wars were attractive, because they were looked upon as equivalent to plunder, or at least they withdrew the gentleman from a life at home which led only to ruin, to one in which he lived in an equal state of excitement, and mostly at the expense of others. The soldier was almost always engaged at home or abroad. And society was not at all improved, for the time, by the exchange of the old feudal wars for civil wars, in which brother fought against brother, and son against father, although it was, no doubt, a part of the long ordeal through which society had to pass in its way to a healthier state of things. Cheating or robbing was, under a variety of forms, a legitimate manner of obtaining money, when it was wanting. It was under this state of things, that nearly all the old feudal houses perished by their own incapacity to live, or fell down gradually from their rank and position in society through their want of the means to support it.

In this state of things the character of woman suffered equally with, if not more than, that of the other sex. She was liable in a greater degree to the same temptations and to the same impulses, and gave in in a greater degree to the same extravagances. Woman, too,

wanted money, and she learnt from the other sex to value money more than other things, even than virtue itself. In the court of France, in the houses of the nobility generally, and indeed almost everywhere, Womankind was not respected, nor did woman respect herself. The State, indeed, was governed by vanity, by the love of luxury and extravagance, by the eagerness for self-indulgence, and by the absence of a respect for true dignity. Any attempts at reform coming from high quarters, were generally harsh and unconciliating, and therefore not lasting. In such times, a single reformer, however high his position, unless endowed with qualities which are seldom attached to humanity, is not often successful. France entered upon the sixteenth century burdened with all the social evils of the fifteenth, and with new dangers before her. For in the midst of the ruin of the old society, religion as well as social order had become embroiled, and the Church had run herself into as much danger as the State. Troubles of another origin were coming upon the land, which also were destined to have an important influence in the formation of modern society.

This intense and almost reckless want of money had, it is true, been met by new means of supplying it. America had made Europe acquainted with its resources of gold and diamonds, and power was beginning to change hands from the aristocracy to the great mercantile interests. The gentry sought to recover their strength by joining in commerce, which contributed further to break down the barrier between the aristocracy and what were now becoming the middle classes. These middle classes were becoming the rich classes, and were therefore rising in power, while public sentiment was of little avail for good, and society was falling into a condition in which there was, so to say, no rule, but everything seemed as though governed by impulse. Whoever raised a banner was sure to obtain followers, whatever the motive; and in the religious wars which desolated France during the latter half of this sixteenth century, the soldiers of the Huguenot armies were not all Huguenots by conviction, but only sought in their ranks a cause to fight for. Hence their triumph was itself but partial, and brought with it no great improvement in public morals. Bassompierre, spoken of above, was a Huguenot general, and the court of Henri IV. was not celebrated for morality.

If, indeed, woman's character were not high in France during the sixteenth century, the history of the times sufficiently explains the reasons. Facts like the following show us how far the sex had been taught to throw aside all those qualities which naturally

belong to it. After the conspiracy of Amboise in 1560, when the prisoners were taken out daily by dozens to be executed, we are assured that the Guises reserved the principal prisoners for the purpose, by their torments, of affording amusement to the ladies of the court after dinner, who then, with the king and his brothers, placed themselves in the windows of the castle of Amboise, in which the court was then residing, while the victims were brought into the court, a few every day, and put to death in the most barbarous manner. We are told further, that the chancellor, Olivier, a man with more gentleness in his character, was so horrified by the atrocities committed on this occasion, that he took to his bed, and died before the end of the month. Such were some of the qualities which seem to have prevailed more or less among Womankind in France at the commencement of the great troubles of the latter half of the sixteenth century. Among the aristocratic classes, especially among those which were naturally taken for imitation, virtue had long been at a discount, and vice reigned without any control. The character of the ladies of the latter half of the century of which I am speaking, and of many of those of the earlier half also, may be studied in the pages of "Branthôme," and in the "Journal of Pierre de l'Estoile." We see them there displaying their immoralities almost to the open day. The civil war of 1580 was ascribed almost entirely to the maids of honour of Queen Marguerite of Navarre, and the young beauties of the court, who, in their feeling of hostility against the King of France, Henri III., distributed their favours almost indiscriminately to all who would join in the insurrection against him, to such a degree that it was popularly called "the war of the lovers." This character of licence had become so strongly imprinted on the French character, that it remained more less attached to it until comparatively recent times. It was only in the Hôtel de Rambouillet, and among les Précieuses, that woman herself began to raise herself to oppose the evil.

In this sixteenth century in France, the whole face of social life had been changed. The old feudal castles, heavy fortresses, with few conveniences, and ill furnished, had been abandoned and exchanged for extensive and elegant châteaux or mansions, filled with furniture and ornaments of the most expensive description. The walls within were covered with rich pictorial tapestries. Everything in fact, told of unbounded luxury and of the love of outward display. Extravagance in expenditure was visible everywhere, but especially in the great centres of population, among the

higher aristocracy, and in the superior grades in the Church, while the sentiments of the olden time and some degree of moderation were found only among the bourgeoisie of the lesser towns, and among the poor nobility of the country. The whole social system had indeed assumed quite a new aspect.

It was indeed an age of innovations and of dissatisfaction with the ages which had preceded it. In the earlier part of it, this sort of scorn for the past was embodied in the satirical caricature of Rabelais. It was under its influence that what was old was now everywhere giving place to that which was new. Even the literature of that age composed for the lower bourgeoisie and for the yeomanry and peasantry teems with reminiscences, often accompanied with regret, of the different state of things which existed when that generation was young. To two of the innovations mentioned in the last chapter I may be permitted to recur, both of which appear to have originated in France. The first was the carosse, or fashionable carriage. It appears that the carosse was still so rare in the time of François I., that the court itself only possessed two. Like the older char, it remained long open to the air, and those who occupied it were only protected by curtains. The idea of supplying it with glass is said to have originated with the Maréchal de Bassompierre in the reign of Louis XIII. The other novelty to which I allude was the stiff wide body of the female dress called the *vertugalle*, or farthingale. Neither of these articles display any great amount of taste or elegance, but some of the jokers either of that or of the following age sought in the latter at least some degree of utility. The pretended short *vertugalle*, according to their derivation of the name, was a mere corruption of *vertu-gardien*, *i.e.*, the protector of virtue, though they seem to have acknowledged that it did not contribute greatly to the improvement of public morals.

The fashions in dress were never carried to greater extravagance than during this century, and, as the ordinary materials of dress itself could hardly go beyond certain limits in cost, this was increased to any extent by covering them with jewellery. This was the case with the men quite as much as with the other sex, as in the dress of the Maréchal de Bassompierre, already quoted. The pride of rank, and of social position, was, too, one may perhaps say, greater than ever, and there seems to have been quite a morbid anxiety to place limitations on the distinctive articles of dress allowed to be worn by individuals of each different class. The sumptuary laws became far more numerous and more various during this period than at any previous time, and they were subject to so

many changes that the sixteenth century might furnish quite a history of the forbidding and not forbidding of particular articles of dress to this person or another. But so much difficulty was found in enforcing any of these injunctions, that, except within the immediate range of the court, they seem to have been but imperfectly carried into effect, and many circumstances combined to throw the costume of people in France into great confusion. We learn from the registrary of the Hôtel de Ville of Paris, that it was a complaint in 1558 that the priests dressed like laymen and the merchants like nobles, while women appeared in the dress of men, and men almost in that of women, as we have also seen was the case in England; this extravagance began to be a little sobered down when we enter upon the seventeenth century. But in my next chapter we will consider the dress of the women in France during the latter half of the sixteenth and earlier part of the seventeenth century more in detail.

THE MARKINGS OF THE PODURA SCALE.

Microscopists must always bear in mind the distinction between the appearance presented by an object under examination which is *correct*, in the sense of representing the true form of the portion seen, and one which is optically true, because it accurately shows the effect of what the object produces upon a pencil of light thrown through it, or upon it in a particular way. If for example we place a compound insect's eye under our instrument, and so arrange illumination and focussing as to obtain a sharp image of some extraneous object in each lens, we do not see the lens itself in a proper manner, but we do see what it does under given conditions, and can thence infer its real form. Whenever an object is capable of reflecting a definite light image, by refraction, or by combined reflexion and refraction of producing certain definite appearances under particular illumination, our instruments are optically right in displaying such effects, although they cannot under such circumstances give us an accurate rendering of the forms and sizes of the bodies or structures by which the effects are produced. Every observer knows that it is easy to obtain hexagonal appearances from globular diatom markings, and that under some conditions objects in relief are seen as depressions, and *vice versa*. When mercury globules are used for testing objectives, it is the optical light images they form, and not themselves, that are the objects

examined, and in like manner when a Podura scale is employed to try the perfection of our glasses and adjustments, no mere sharpness and distinctness of the dark "notes of exclamation," must be taken as proof that such markings really indicate any corresponding structure of the scale.

In objects capable of exerting any complex action upon light, it is extremely difficult to know when seeing ought to be believing that the image presented to our eyes is actually that of the object itself. If indeed as is continually the case, the object presents any difficulty, we are only justified in assuming that we know its real form after we have gone through a series of experiments to modify or verify a particular appearance. For this purpose we resort to various modes of illumination, and carefully compare the results. If objects are elevations, we ought to be able to throw shadows from them by unilateral light, or if they are too transparent to give definite shadows, we ought to notice their action upon light beams coming in different directions. Another mode of testing elevations or depressions is by accurate focussing with sufficiently high powers, the parts which come first into view being regarded as the highest. This must be so if they are real parts, but they may be optical light images only, and against this source of deception we have to guard.

No doubt our greatest difficulty arises from the limited experience we have of the appearances presented by bodies under transparent illumination, or as seen with an obliquity of illumination not common or even practicable in our every day exercise of our eyes upon common things.

Those who habitually bear in mind the preceding facts and reasonings, have probably always doubted whether the Podura "notes of exclamation" correspond with real objects of that form on the scale itself. Mr. Brooke indeed stated that, on one occasion, he had seen a broken scale exhibit the note of exclamation like a battledore stuck into a membrane by its handle. To many observers who have fully admitted the value of the note of exclamation appearances with their light spots, as tests of the correction of objectives, another focussing, giving a puckered aspect, has been held to be more correct, and Mr. Slack has repeatedly expressed his belief that the true markings are folds.

Recently Mr. Wenham has published in the "Monthly Microscopical Journal"* some important remarks on the structure of Diatoms and Podura scales, in which he refers to a method he proposed some time ago, and which has been strangely neglected,

* July, 1869.

of illuminating objects by causing pencils of light to be thrown at such an angle through a glass slide, to the upper surface of the covering glass, as to insure total reflexion back again upon any object lying below on the surface of the slide. One mode of obtaining this peculiar dark ground illumination is described as consisting in a small, nearly hemispherical lens, with its projecting surface ground down in a plane, parallel with its flat surface, and having a thickness of about one-third the diameter of the sphere. The flat facet of the lens is blackened. The radius of curvature should be about two-tenths of an inch. This lens is cemented to a glass slide with Canada balsam, so that its truncated portion is uppermost. It is used in conjunction with a parabolic condenser, the slide being mounted, so that the truncated portion of the lens hangs downward in the hollow of the condenser. Mr. Wenham states that in a Podura slide, some scales may usually be found attached to the upper surface of the *slide*, and not to the cover, and such scales will be found illuminated with singular beauty and brilliancy.

In this case, from his account, the scales are not seen by reflected but by transmitted light—at least so we understand the following passage. "These (scales) have become detached from the cover and lie upon the under slide, and by their close adhesion *prevent the total reflexion at the spot beneath*, consequently it is like a hole made in a dark lantern, and a flood of light escapes through the scale." He adds, "herein, as with the parabolic condenser, the markings are most intensely illuminated, and appears the brightest, and under a good $\frac{1}{1\,2}$ or $\frac{1}{2\,5}$, contrasted with the surrounding darkness, the aspect of the Podura is at the first glance so novel, and different from what we have been accustomed to, that the black interspaces may be mistaken for markings pointed in the *reverse direction*; but on looking again they are still the characteristic "note of exclamation" figures the same as ever. The rays from the lamp must first be rendered parallel by a bull's eye condenser. On our sliding this on the table sideways, the light will gradually vanish from the object and give a dissolving view; and at last there is only the faint outline of the scale with its barely perceptible blue surface, dotted over irregularly with minute *bright blue circular spots*. This appearance is so different from anything seen in the Podura, that were I to exhibit it as such, not one of its numerous friends would recognise it. But on bringing the light gradually forward again, we have at once most palpable proof that there is no deception. These spots of light emanate from the bent ends of the

markings, for these having both a higher refractive power, and being also, perhaps from their prominence, in more intimate contact with the glass, are the last portions to admit the light at the time when the angle becomes so great that the margin is approached, when total reflexion again begins to prevail in the glass, against the less refractive power of the scale which causes its transmission. As the light is again drawn forward it plays over the individual markings, and gradually discloses them, from the first bright point to the taper ends.

"As in this mode of illumination we see the scale as nearly as possible as an opaque object, without the false appearances arising from refraction, I think it affords some proof that the markings of the Podura consist in reality of the taper bodies generally known, and which have considerable refractive power and some amount of opacity, and that there are only one series of them, but that instead of being planted on *one side* of the scale, they are enclosed between two membranes." Mr. Wenham further states that the action of these scales on light "affords strong proof that there is a flat membrane in close contact, and adhering to the glass slide, destroying the rotal reflexion in the entire space occupied by the scale." But, is he not in error when he speaks of the scale being seen "as nearly as possible as an opaque object"? As we understand his description, the scale acts like "the hole in the dark lantern," to use his own image, and is thus seen by *transmitted* light.

In the August number of the "Monthly Microscopical Journal," the Rev. J. B. Reade takes up the question of Podura markings, and describes the results he obtains by his prism illumination, described by us in our last number.

Mr. Reade says:—"The following description is accepted by friends who have worked with me. The scale of the Podura consists of two membranes, between which there is a series of small, solid spherules. These spherules or beads are often arranged in parallel rows towards the edge of the scale, and in the centre they are placed rather diamond-wise. Under a power of 1200 linear, I have found 24 spherules in $\frac{1}{1000}$ of an inch on the 12-inch horizontal diameter of the field, and 6 on the vertical diameter. Hence, in the latter direction, they are about $\frac{1}{6000}$ of an inch apart, and in the former, the interval being about equal to the diameter of a spherule, they are about $\frac{1}{48000}$ of an inch apart.

If, now, we could place a series of spherules in almost close contact on the vertical diameter, we should have parallel rows of

about forty-eight spherules enclosed between the membranes as in a tube, and the membranes themselves would touch and be in close contact along the parallel intervals. Now, let this close contact of the membranes continue, since, in point of fact, it really does exist on the scale, but remove the spherules we have supposed to be inserted. Then we have an empty space like the empty finger of a glove between spherule and spherule, on the vertical diameter of the field. The sides of this tubular space cannot preserve their parallelism without the support of the supposed additional spherules, and therefore they tend to fall together, having the diameter of the existing spherule for the width of the tube close to the spherule, and thence tapering to a point just before a lower spherule is reached. Thus we have on the vertical 12-inch diameter under a power of 12,000 linear, a set of six spherules at the top of six hollow cones of membrane, which may be shown in brilliant objects on a dark ground, while, at the same time, they naturally prevent the direct light of the usual achromatic condenser from passing through them. If this is the true explanation, and I believe it to be so, it is a curious fact that simple darkness in the hollow cones —the absence of light and not the presence of shadow—supplies our skilled opticians with their best test in the shape of a note of exclamation, having exquisite definition, and apparent materiality."

We hope our readers will make experiments and observations on this curious question, and we shall be glad to know the results at which they arrive. By using a single radial slot in an achromatic condenser, it is easy to get an appearance of small round white dots on the Podura scale, and many other modes of testing the matter will occur to practised observers.

It should be stated that Dr. Pigott has, for some years, investigated the Podura, and declared the true markings to be round dots, and he sent a paper on this subject to the Royal Microscopical Society before the close of its late session.

A careful examination of irregular looking markings in ordinary butterfly scales, will show that those, like longitudinal ribs, may be frequently resolved into a series of dots, or in some cases of disks, like rows of small round biscuits, placed side by side. Even in Lepisma scales appearances of this kind may be noticed, especially in the rounded ones.

THE INSECTS OF NATAL—A FURTHER PERSONAL REMINISCENCE.

BY DR. MANN,

Superintendent of Education of the Colony.

A REMARK made in a recent page concerning the pacific idiosyncrasies and demeanour of Natal insects is further illustrated by a tribe whose English representatives are among the most aggressive of winged creatures. The wasps of Natal are principally hornets of formidable dimensions. They are lengthy, brown insects, with especially taper waists, and are capable of inflicting severe and painful stings. They are constantly under notice, for they make hanging nests of paper, which they insist, most pertinaciously, upon establishing in the shady interior of the verandahs of houses, or under the roofs of out-houses. In the early season of the spring the pioneer foundress of a new nest may be constantly seen visiting house after house, and deliberately examining inch after inch of plastered and thatched surfaces until one particular spot is decided upon as presenting unexceptionable ground for operations. A small dark brown foot-stalk is then quickly moulded, and firmly attached to the rough surface of the plaster, or to the fibres of the thatch, and from this the busy insect hangs, fixing pellet after pellet of papery pulp, and flattening out the structure with her mandibles, working backwards all the while, until the foot-stalk grows into a vast hanging pear-shaped mass, as large as an ordinary hat. A single cell first appears at the end of the foot-stalk. Each successive layer then expands to larger, and yet larger, dimensions, until the entire structure holds several hundred six-sided, prism-shaped, chambers arranged compactly in successive layers. An egg is deposited in each of these chambers, almost as soon as it is formed, hence a band of helpmates very soon emerges from some of those first constructed to aid in the further labours of construction. The original builder has, at frequent intervals, to leave the growing structure depending from its stalk, in order to collect fresh stores of pulp, and in doing this has very frequently to conform to certain domestic arrangements of the household with which she has associated her building, using such opportunity of ingress and egress as are afforded by circumstance. This acquiescence is rendered in the most orderly way, the hornet hanging from one of the cells in her state of enforced repose when her passage to surrounding regions of supply is temporarily barred. If, when the attachment of the nest

by its foot-stalk is first commenced, the insect is suddenly struck to the ground, she lies there puzzled and stunned at the surprising onset for a brief period, and then, collecting her energies, rises to renew her labour on the original site, and this she repeats any number of times without ever seeming to accomplish the perception, as an English wasp would do, that the sudden shock has been the work of an enemy. An English wasp would rise from its discomfiture with a rush at the rash assailant, who would certainly feel the point of the poisoned dagger before he had any chance of repeating the onslaught. It is a matter of the very rarest occurrence to see the Natal hornet engage itself in single combat. It flies rapidly about in an excited state in a storm of missiles pugnaciously aimed at its devoted head, until it at length succumbs to some stroke of destiny; but it rarely, if ever, seems to detect the source of the attack, or indeed fairly to apprehend that mischief is intended.

The scale-winged (*Lepidopterous*) insects of Natal are both numerous and interesting, more especially in the night-flying section—or moths, which are many of them of large size, and of very gay and beautiful plumage. When the gardens are filled with the heavy fragrance of the Brugmantia, in the deepening twilight of still evenings, the Oleander hawk-moth is seen poised upon its vibrating wings by myriads, with its unrolled trunk plunged deep into the honeyed recesses of the flowers. In the dim light, the eye alone can scarcely note the difference between this insect and the honeybird, whose habits are singularly like to its own. The hawk-moth is, commonly, quite as large when hovering on the wing, and its massive protruded trunk very remarkably resembles the long, curved beak of the bird. The butterflies of Natal are not, upon the whole, as bright and gay, or as attractive, as their magnificent South American congeners. Perhaps none of them can be said to exceed, either in brilliancy of colouring, or in size, the European swallow-tail, and few of them rival this prince of the race. The most beautiful specimens of these flower-insects are restricted to the coast region, where the evergreen bush is laden with a tangle of bright blossoms for the greater part of the year, and quite through the sunny months of the winter season.

But it is in the earlier stage of the larva or caterpillar form of existence that the Lepidopterous insects of Natal are most worthy of close observation. Their ingenious operations come under notice at every turn. The silk-worm of the mulberry tree is being gradually introduced into the colony, which, from the extraordinary luxuriance with which the white mulberry thrives in all localities,

promises soon to become a silk-producing land. There are sundry species of the *Bombyx* family found, originally native to the colony; among them the *Bombyx processionea*, the procession caterpillar, so graphically described by the naturalist Reaumur. The author once encountered a battalion of these insects in full array, under circumstances which afforded him an unusually favourable opportunity of watching their proceedings. He was driving in a light ox-waggon, in the company of a friend, along a broad, open road, within a few miles of the Port of Durban, when he observed that the wheels of the vehicle had rolled through a long track of some moving objects that stretched diametrically across the path. On stopping the oxen, and running back to examine this trail, he found a long line of living caterpillars, gapped in two places by the Juggernaut wheels. The road, at this spot, was some fifty or sixty yards wide, and was without banks or fences, but passed on each side into the dense bush of tangled evergreen. The column of the caterpillars came out from the bush on one side, and passed on into the concealment of the foliage in the opposite direction. It was composed of four caterpillars abreast, and in close contiguity with each other, side by side. Each caterpillar in the line touched the tail of the one that preceded it by its mandibles or feelers, so that there was no perceptible break in the lines of the array. When the wheels of Juggernaut's car rolled across the battalion, the column was interrupted for a brief interval. The head of the column continued its march, but the portions that were intercepted by the wheels stopped, the leading insects in each section missing the accustomed guidance of the individuals that had been ranked first in front. After a short period of suspense, however, the broken ranks were closed up, much in the same way as the broken ranks of the Light Brigade were closed in the valley of death at the Balaclava charge, and the procession continued its way, leaving the dead upon the field. In a short time the rear ranks emerged from the hindward bush, and the entire column then gradually disappeared into the opposite and impenetrable undergrowth. There were four insects abreast through the entire length of the column that was under observation. Each caterpillar was about as thick as an ordinary cedar pencil, and some two inches long. It was densely covered with closely-set tufts of hairs, carried erect like the bristles of a bottle-brush.

Upon the whole, the straight-winged or Orthopterous tribe of insects is, in Natal, next to the ants in abundance and importance; and of Orthopterous Natal insects the large green Mantis is cer-

tainly a distinguished chief. He is a very remarkable fellow, powerful alike upon wing and leg, but much given to fits of lethargy and brown study. His traditional religious exercise, indeed, is simply a lying in wait for what the gods may send in the way of food. He fixes himself, as if in wrapt contemplation, upon some convenient stalk or leaf, and then bends up his chest and shoulders into an almost erect position, pressing together his arms in front, and looking well out before him, with the palpi of his lips slightly vibrating. In this expectant mood he allows himself to be coaxed with the finger, merely staggering back a pace or two, and fixing his goggle-eyes upon the biped who vouchsafes this personal attention. If he lights upon a perpendicular window or wall, when in this vein of "religious" ecstacy, he seems to remain for hours together without motion, but all the while he mounts imperceptibly up and up until he reaches the ceiling or roof which limits the chamber in the upward direction. The closest watching does not show how this most gradual of all climbings is accomplished. Not a limb can be seen to move, yet up, minute after minute, he glides. It is while he is in these fits of expectant ecstacy he seizes his prey. He is essentially a carnivorous feeder, and pounces stealthily upon any unwary insect that settles within convenient reach, seizing the victim between his upraised legs, and fixing it there between the row of spikelets with which these prehensile limbs are fringed. After a deliberate inspection of the morsel held in this position, he goes to work with his jaws.

It was the author's fate, upon one auspicious occasion, to watch one of these "religious" insects engaged in a remarkably appropriate occupation. A dignitary of the Natal Church, who has since made some noise in the world, was, one warm summer evening, with all the windows and doors of his chapel open to the refreshing breeze, preaching by candle-light, when a huge green Mantis whizzed into the assembly, and perched himself upon the preacher's white necker-chief, and first folding his arms into the prayerful attitude, he raised his chest and shoulders into wrapt attention, turning his goggles from side to side, and following responsively each motion of the spectacles that glanced, now on this hand and now on that, from above. He remained fixed in his convenient position until properly dismissed with the rest of the congregation at the close of the sermon, and he did not even then depart at once, being puzzled and staggered, in all probability, by some of the novel doctrines he had been listening to. Of the two parties concerned in this rencontre the preacher was certainly less conscious than the listener. Although

the Mantis is essentially a flesh-feeder, he by no means despises a dessert drawn from the sister kingdom of organized supply. It is quite worth while to watch his proceedings as he clips away at white muslin curtains, leaving broad gaps as traces of his appetite and energy. The allied but somewhat aberrant group of Phasmids, which comprises the stick-insects and spectre-insects, also in force in Natal, are exclusively vegetable feeders. They are, for the most part, devoid of wings, and are strangely modelled into the resemblance of dry sticks and twigs. They are without the prehensile powers of the Mantis, and live indolent lives stretched out in the sunshine, in the security of their masked concealment, with their legs extended in the same direction as their bodies to carry out the delusion. When they shift their quarters, they draw themselves lazily along the shrubs and trees which they select for their haunts.

The Mantis family and spectre-insects are distinguished from all other forms of Orthopterous insects, by possessing the power of using their legs for walking or running. The rest of the Orthopterous insects are either crickets, locusts, or grasshoppers, which are all leapers instead of runners, with powerful long legs and thighs adapted to this method of movement. These leaping insects are encountered everywhere in South Africa, many of them rejoicing in very brilliant liveries of scarlet, and gold, and green. When disturbed in their feeding haunts, they leap boldly into the air, and then expand their wings and prolong their leap into a short flight of a few yards, their course being marked alike by the whirring and rushing sound of their wings, and by the flashing of their bright colours in the sunshine. A locust hunt, conducted by cocks and hens, is a very amusing spectacle. When a locust leaps from its leaf and expands its whirring wings, the fowls converge from their various stations around upon the point where their trigonometrical calculations and experience have taught them to look for the prize, most generally just in time to witness a fresh departure, and to commence a fresh race. The true locust, and an allied tribe of his first cousins, are found in Natal in considerable numbers during the height and close of the warm season, and levy a somewhat important tax upon the green crops. There is, however, at present, no instance known within Natal, since the colony has been the seat of civilized settlements, of a devastating visitation of these insects. On the higher table-land of the continent they are much more numerous and destructive. It is generally believed among the wild natives that the locust was not known in Zululand until the year

1829, when it was sent from the Delagoa Bay district further north, by a chief called Sotshangana, back to Zululand with a party of Zulu invaders, charged to carry famine in its train. It is, however, questionable, whether upon the whole, the wild natives does not derive more benefit than harm from the devastator. He waits until the cool evening has paralyzed the moving power of the insect, and then sallies forth with sacks and skins, and whatever other form of receptacle he can turn to account, and sweeps up the loiterers by millions. He then carries the captive burthen, often with the aid of pack oxen, to his kraal. The insects are there first steamed in close vessels over a fire, and then dried in the sunshine, and after being freed from their legs and wings, by a species of winnowing, are stored in baskets in the granaries, like corn. The dried locust is ground to powder between stones, and converted into a kind of porridge with water, when it is eaten. In some situations, in the upland region, the Kaffirs grow quite fat in a good locust season. The insect is so highly esteemed that there are native magicians who grow wealthy upon their reputation of being able to make locusts as well as rain.

The beetles in Natal are, of course, a countless legion, as they are everywhere, and affect the most diverse modes of life, from the miners who never leave the ground, and the pill-makers who roll their huge balls of dung an inch and a half across backwards, and sometimes seem to rival the feats of Leotard in the adroitness with which they mount their rolling spheres, to the phosphorescent fire-flies that almost mingle with the stars in the clear South African night. During about three months of the year the tall grassed pastures are spangled the night through with dancing fires, that would certainly not be distinguished from the bright sky shiners above, if it were not for their incessant movement. Again and again, the author has compared the lanthorn of some temporarily still insects with a blue-tinted star shining in nearly the same line, and has been for the time quite unable to distinguish the terrestrial from the celestial spark. The meteor, or falling-star, is the exact counterpart of the fire-fly, when it chances to be sailing evenly across the dark concave of the sky. In the Dutch-founded towns, such as the city of Maritzburg, the water-courses with which the streets are everywhere bordered, are fringed with dancing lights all night long. The insect is a small dark Elater, probably allied to either the Pyrophorus, or Cucoyos, with weak and soft elytræ, and with as dull and grovelling an aspect as anything that can be conceived when its lanthorn is out, or, when it is examined in the full

radiance of day. The light shines through the integument of the last two or three rings of the abdomen, and can be seen for a surprising distance. The hands and figures of a watch can be easily discerned under the illumination afforded by a single insect. There is a wingless glowworm which quite rivals the fire-fly in brilliance, and a small centipede which gives even a brighter and seemingly more enduring light. The phosphorescence of these beautiful insects continues for a brief interval after their immersion in spirits of wine.

The Tsetze fly is not found in Natal, nor for some hundreds of miles beyond the Northern frontier of the colony, but there is no dearth of the two-winged lancet-bearers in every variety of form. The mosquito is scarcely seen in the dry upland districts of the colony. For some years it was not known in the capital city, Maritzburg; but it is now found there during about four months of the year. Some old colonists, however, state that it was abundant at Maritzburg at an earlier period, and that it then disappeared for some seasons. It would be a matter of some practical interest if it could be determined whether this most inveterate tormentor does appear and disappear in the same district, thus periodically and fitfully. A friend of the author, who resided some years in the close vicinity of the Port of Durban, which is one of the strongholds of the mosquitoes, enjoyed almost an immunity from this winged pest during some seasons, in consequence of keeping fragments of old iron in his water-tanks.

There is only space upon this occasion to allude to one other Natal insect, and this must be excepted from the general character for good behaviour that has been put in. This culprit of ill-repute is, however, not a *winged* insect. It is a curious steel-grey, slimy creature, with a body shaped like a fish, and with a broad tassel-like tail, composed of diverging spikelets. It is almost entirely composed of slime, and microscopic scales, being crushed by a touch into a speck of glistening moisture. It is known under the familiar designation of the fish-moth; because it is as destructive as the clothes-moth of England to all kinds of woollen fabrics, having, however, habitually the conscience to prefer old clothes to new ones. It is nocturnal in its habits, and very agile; and its especial delight is to found colonies in instrument cases lined with green baize, and which are rarely opened. Next to these instrument cases its affection is for libraries of books, and after the books, it selects wardrobes of every kind, and more especially clothes that have starch mingled with their fibres. It consumes all these things with ruthless

voracity, and, indeed, scarcely leaves any fabric that is useful to man unriddled. It commences its career of destructiveness as a very minute, and hardly perceptible creature, but it grows rapidly to considerable dimensions, after the fashion of the caterpillar, rather than after that of the perfect insect, as a natural result of its large appetite. It is properly a Lepisma, the Thysanourous insect that is valued by the microscopist on account of the beautiful scales that its slimy body is covered with. The steel-grey lustre is in reality due to its mailed armour of scales. The scale of the Natal fish-moth is in every particular microscopically identical with the scale of the English Lepisma. There is scarcely a doubt that that destructive insect is an importation from India, and not a proper denizen of the place, and this may possibly account for its exceptional character. The only protection that can be found against the ravages of this active, and at the same time stealthy pest, is to isolate all wardrobes and chests containing clothes, upon legs that are dipped into little cups containing Stockholm tar, which the fish-moth has not yet learned to wade, or swim through. The protection is not, however absolute, because the insect has the habit of making a sudden headlong shoot if surprised or suddenly alarmed, and if it is basking upon the wall, or the ceiling, at the time that it takes its departure, it of course lights exactly where it is least required.

Sir Emerson Tennant, in alluding to the habits of this insect, whose acquaintance he had made in Ceylon, states that it bears an undeservedly bad name, and that it is really a carnivorous, and not a vegetable feeder, and that it busies itself with the eradication of minute Acari, which are themselves the real authors of the depredations that are attributed to the Lepisma. This, however, is certainly not the case. The Lepisma eats paper, and cotton, and woollen, and silk fibres beyond all question. Nothing is more common than to see the juices of its slimy body deeply impregnated with the crimson, and purple, and green dye stuffs of the covers of books that it has been pasturing upon. The consumption of green baize is infinitely more rapid and vast than could be by any means accounted for by Acari. In the case of the destruction of muslin fabrics, the absence of all living forms, saving the fish-moth, is unmistakeably verified by close microscopic investigation. The power of this slimy, almost altogether liquid creature, to consume firm fibrous substance, is one of the most curious points connected with its economy.

The tenacity of life exhibited by the fish-moth is, however, even

more wonderful than its destructive voracity. The author, upon one occasion, placed three individuals together in the interior of a wine-glass, of conical shape, which serves as a very efficient prison to these creatures in consequence of their inability to climb the steep, slippery surface of polished vitreous substance. For a few days the prisoners lived together in apparent harmony; but, at the end of that time, one which chanced to be rather larger and stronger than the others, devoured its two companions, leaving only a small dry patch of steel-grey scales. At the end of four months, the solitary prisoner, who had not had any trace of food after the disappearance of his companions, was still fresh and lively. Subsequently to this he gradually dried away into a grey glistening speck.

Another experiment, relating to the voracity of these insects, in which the author has a strong personal interest, is at this present time in progress. Three years since, when he left Natal, several cases of books were enclosed in metal-lined boxes, which were soldered up and left in store. As much care was taken as was practicable to free the volumes from the fish-moths before placing them in the cases; but, as a matter of course, with such insidious and stealthy depredators this could only be imperfectly accomplished. There therefore remains pending the very important question of how many of the volumes will be found to have survived when the cases are next opened. A report of the result of this experiment must be presented on some future opportunity.

The spiders of Natal are, many of them, lusty fellows, and commonly decked in gay livery, of which yellow and orange, relieved by black, are the most frequent. A large black-and-yellow spider hangs the verandahs of the houses with nets of bright yellow silk that goes far towards catching men, as well as flies, when they accidentally stumble against the meshes. Several of the spiders of intermediate size furnish threads of great value for micrometers and other delicate astronomical instruments. The only proceeding requisite to procure a good supply of this web, is to select a likely insect, and keep it upon an outstretched stick or rod until it gets weary of the imprisonment, and begins to let itself down to the ground by its own thread. By then turning the rod round as the spider spins, a reel of several yards, in the best possible condition, may be secured before the spinner reaches the ground and accomplishes its emancipation.

WHAT RAYS OF LIGHT WATER-FLEAS SEE.

M. P. Bert has a paper in "Comptes Rendus," entitled, "On the Visibility of different Rays of the Spectrum to Animals," but as his experiments were confined to water-fleas, a restricted and less ambitious title would be more correct. He begins by asking, "Do all animals see the rays of the spectrum which we call luminous? And do they see any not visible to us? If there is an identity of the standard of luminous perception for them and for us, is there a similar identity in the relative force of visual sensations produced by different regions of the spectrum.

"These questions which have occupied philosophers and physiologists, have not hitherto been studied experimentally, yet they have an undoubted interest in natural philosophy. Not being able to experiment on creatures belonging to all classes of the animal kingdom, I have nevertheless been able to select some as remote as possible from ourselves in general structure, and in the character of their eyes. The Daphne water-fleas so common in fresh water, are very sensitive to light, and at night will swiftly approach a candle brought near them. I placed a certain number of these animals in a dark vessel, to which light could only penetrate by a narrow slit. When any portion of a spectrum formed with electric light was allowed to fall on this slit, the Daphnes swam towards it from all quarters. They would thus assemble in the red rays, the violet ones, or those intermediate. Thus the first point is established, that they see all the rays visible to us.

"When the ultra-violet portion of the spectrum is presented to them, and it gives so feeble a light as to afford us no distinct sensation, the water-fleas seem quite indifferent to it; but at the extreme red it is quite different, for there where we see the light very well, they are agitated and impressed. If the prism is turned so as to throw still less refrangible rays, they immediately disperse. This region, so rich in rays not visible to us, is likewise invisible to them. Thus the second point is established, that these animals do not perceive rays invisible to us.

"In examining successively the action of the differently coloured regions, it is easy to show that these creatures come most quickly to the brightest lights. Thus the yellow, the red, and the green attract them much faster than the blue and the violet. This result is most manifest when we operate simultaneously with all parts of the spectrum. If a complete spectrum is thrown upon a glass vessel

with parallel sides, so that the luminous portion occupies about half the length of the vessel, all the little animals are thrown in agitation, the immense majority grouping themselves in the mid region from orange to green, a certain number stopping in the red, much fewer in the blue, and still fewer towards the more refrangible parts, while scarcely any are seen beyond the red and in the ultra-violet. Thus the rays which have the greatest luminous intensity for us, have it likewise for them, yellow taking the first place. Thus the third point is established, that their perceptions of the intensity of various rays is the same as with us.

"If we consider on one hand that the structure of our eyes is different from that of the single eye of the Daphne—an eye without facets—and on the other hand, the enormous distance which separates them from us as zoological types, we are up to a certain point authorised to make a generalization from the preceding facts, and to conclude, till the contrary is shown, that the whole series of animals see the same rays, and see them with the same relative intensity."

This conclusion is far too hasty for real science, though it may possibly be true.

ASTRONOMICAL NOTES FOR SEPTEMBER.

BY W. T. LYNN, B.A., F.R.A.S.,

Of the Royal Observatory, Greenwich.

MERCURY will be at his greatest eastern elongation on the 25th day, and will probably be visible in the evening immediately after sunset. On the evening of that day he sets at 6h. 17m., and during the whole month about half an hour after the Sun. He is in the constellation Virgo, and will be very near Spica on the 19th.

VENUS sets about an hour after sunset throughout the month. She will be near Spica on the 10th, and continue to journey rapidly towards the south, so that by the end of the month she will be in the constellation Libra, and very near *a* Libræ on the 29th.

JUPITER is now a conspicuous object during the greater part of the night. At the beginning of the month he rises about 9 o'clock, and, at the end of it, about 7 in the evening. He is the constellation Taurus, and will be near the Moon on the 25th. The following

is a list of those phenomena of his satellites which will be visible before midnight :—

DAY.	SATELLITE.	PHENOMENON.	MEAN TIME. h.	m.
Sep. 1.....	III.....	Occultation, disappearance	10	5
„ 1.....	III.....	Occultation, reappearance	11	43
„ 2.....	II.....	Occultation, reappearance	11	24
„ 5.....	I.....	Eclipse, disappearance ...	10	40
„ 6.....	I.....	Transit, egress.....	11	26
„ 8.....	III.....	Eclipse, reappearance.....	10	32
„ 9.....	II.....	Eclipse, reappearance.....	11	22
„ 9.....	II.....	Occultation, disappearance	11	36
„ 13.....	I.....	Transit, ingress	11	4
„ 14.....	I.....	Occultation, reappearance	10	22
„ 16.....	II.....	Eclipse, disappearance ...	11	43
„ 18.....	II.....	Transit, egress.....	10	23
„ 19.....	III.....	Transit, egress.....	9	4
„ 21.....	I.....	Eclipse, disappearance ...	8	57
„ 22.....	I.....	Transit, egress.....	9	30
„ 25.....	II.....	Transit, ingress	10	30
„ 26	III.....	Transit, ingress	11	5
„ 28.....	I.....	Eclipse, disappearance ...	10	51
„ 29.....	I.....	Transit, ingress	9	7
„ 29.....	I.....	Transit, egress.....	11	17
„ 30.....	I.....	Occultation, reappearance	8	24

All the eclipses take place to the left of Jupiter, as seen in an inverting telescope; the first satellite disappearing in the shadow when very near the planet, and being behind him at emergence from it.

SATURN begins now to set somewhat early in the night; at 10h. 6m. on the 1st, and at 8h. 15m. on the last, day. Being in Scorpio, his position in the heavens is always very low, and he will scarcely be observable after the present month.

THE MOON.—Her phases are :—New Moon at 6h. 7m. on the morning of the 6th; First Quarter at 9h. 23m. on the evening of the 12th; Full Moon at 8h. 41m. on that of the 20th; and Last Quarter at 9h. 10m. on that of the 28th. She will occult one star only within the earlier hours of the night, which is μ Sagittarii, of the fourth magnitude, on the 13th. The disappearance will take

place at the dark limb at 5h. 34m., 141° from the Moon's highest point to the right hand; the reappearance at the bright limb at 6h. 4m., 170° from that point towards the left hand.

WINNECKE'S PERIODICAL COMET.—Observations of this comet are reported from May 8 to June 26, by Julius Schmidt, Director of the Observatory at Athens; from April 13 to June 21, by Professor Bruhns, and his assistant Herr Vogel, at Leipzig; from April 30 to June 9, by Professor Schönfeld, at Mannheim; and from April 14 to June 5, by Herr Wolff, at Bonn.* The great faintness of its light has precluded much being done with it in the way of physical observation. On May 14, Vogel saw very distinctly a tail-like lengthening; and Schmidt speaks of seeing a small trace of a tail on June 25. Schönfeld states that in part of April and May, it appeared to have, not one, but several, centres of condensation, and Vogel says that, in the beginning of June, it had a much greater resemblance to a star-cluster than to a nebula.

Dr. Winnecke succeeded in finding and observing this comet again on the 4th of August at half past 2 o'clock in the morning, and states,† that it was then much brighter and larger than when at the same distance from the Sun in the month of May before its perihelion passage. He estimated its interior brighter part at 7′ in diameter; but it appeared to be surrounded by diffused faint light of much greater extent. As it is possible that it may still be visible in the first half of the present month, we give its places for each fourth day as calculated by Dr. Winnecke himself, here reduced to Greenwich midnight. The comet was in perihelion a little before noon on the 30th of June. At the beginning of this month, its distance from the Sun is about 115 millions of miles, from the Earth about 46 millions, nearly the same as it was in the middle of May.

DAY.	R.A.	N.P.D.
	h. m. s.	° ′
September 1	3 31 0	97 16
„ 5	3 24 21	98 21
„ 9	3 17 5	99 23
„ 13	3 9 12	100 22

During the above period, the comet is in the constellation Eridanus, and it will be very near the 3rd magnitude star, ϵ Eridani, on the night of the 4th. Of course it can only be seen in the early

* "Astronomische Nachrichten," No. 1767.
† "Astronomische Nachrichten," No. 1768.

morning hours, and then only by those who are possessed of really good instruments.

Solar Physics.—This highly interesting branch of research continues to be well followed up, and we may have occasion before long to enter into it again in some detail. Professor Zöllner, of Leipzig, has recently obtained, by the aid of a new spectroscope, a considerable number of views of the so-called prominences; higher waves, as we must now consider them, of the chromosphere, or great hydrogen-atmosphere, the continuity of which was established by Mr. Lockyer. Great and rapid changes in these are exhibited in Zöllner's drawings, almost comparable to those which are sometimes seen in the cumulus clouds in our own atmosphere. He speaks also of a flickering flame-like motion in one of small breadth and great altitude which he saw on the 1st of July last, in the afternoon, the appearance of which, when he first caught sight of it, so astonished him that he could scarcely, to use his own expression, believe his eyes.

Variable Stars.—Eleven of the periodically variable stars will arrive at a maximum of brightness some time during the present month. Of these, five, U Geminorum, R Monocerotis, V Virginis, S Hydræ, and R Cancri, will not, in this part of the world, be above the horizon at times favourable for observation. The following table of five others, in the order of their length of period, may be found useful:—

NAME OF STAR.	R.A.	N.P.D.	PERIOD.	MAGNITUDE.		DAY OF MAX.
	h. m. s.	° ′	days.	Max.	Min.	
R Scuti	18 40 30	95 51	71·7	4·7	9	Sept. 5
S Aquilæ	20 5 35	74 46	148	8·9	11	„ 12
R Arietis.....	2 8 41	65 33	186·0	7·5	12·5	„ 16
T Aquarii	20 43 2	95 38	203	7·0	13	„ 5
R Persei	3 21 43	54 47	206·8	8·0	12 6	„ 17

The eleventh of the stars to which we alluded is perhaps the most remarkable of all the variable stars—*o* Ceti, commonly called, from this circumstance, Mira Ceti, or the wonderful star of Cetus. Its period has been accurately determined, from a great number of observations, to be 331·3363 days; but it would seem that there is some other longer period, amounting to about ten years, at the recurrence of which its maximum brightness is greater than usual. The last two maxima occurred on 1867, December 15, and 1868, November 7, the former being a very large one (the star nearly equalling *α* Ceti in brightness), whereas the latter was faint in

comparison with the others, as the variable did not quite come up to λ Ceti, a star of the 4½ magnitude. In this (the 1868) appearance, the duration of visibility to the naked eye only amounted to eighty-six days (September 29 to December 24), whereas the average duration is 124 days, and in the year 1859-60, the star continued visible without a telescope for the space of 145 days, from August 19 to January 11.* The average maximum and minimum of brightness are 1·7 and 9·5; and a maximum will take place about the end of the present month. The place of the star is, R. A. 2h. 12m. 43s., N. P. D. 93° 34′. It is exceedingly desirable to follow up this inconstant beauty, and endeavour to ascertain the exact laws of her extraordinary fluctuations, with a view to obtaining some clue to their cause. She rises, at the beginning of this month, about half-past nine o'clock in the evening, and at the end of it, at half past seven, so as to attain a considerable altitude even in the early hours of the night.

Dr. Julius Schmidt has lately succeeded in establishing a periodicity of small variability in the little star *u* Herculis, which is usually above the fifth magnitude, but which he saw on the 16th of May as faint as its near neighbour, *w* Herculis, that is, scarcely brighter than the sixth magnitude. He thinks that the period is about thirty-seven days, or possibly only half that time. It is a point deserving of attention, and the proximity of the two stars makes the comparison of their relative magnitudes from time to time an easy matter of observation. Their approximate places are :—

	R.A.	N.P.D.
	h. m. s.	° ′
u Herculis	17 12 30	56 46
w Herculis	17 15 46	57 22

It will be noticed that they are on the meridian this month about sunset, and will be above the horizon until after midnight.

The eclipse of the Sun on the 7th August was successfully observed in America. The details will be alluded to in the next number, when full particulars have been received.

* Professor Heis, in "Astronomische Nachrichten," vol. lxxiii. p. 199.

ULTRA-VIOLET SPECTRA.

BY M. MASCART.*

THE observation of ultra-violet spectra will, without doubt, enable us to solve certain questions, concerning which the luminous spectra do not give us sufficient information, and with this view I commenced the study of spectra of solar light, and metallic vapours, in the ultra-violet regions, reproducing the spectra by means of photography.

Iron is one of the metals, the rays of which present the greatest number of coincidences with the spectrum of solar light, and M. Angström has observed four hundred and fifty. He has remarked that these coincidences occur especially in the violet, and that in that region the greatest number of solar dark rays are due to the existence of iron. The same observation applies to the ultra-violet region, where I have noticed more than one hundred new coincidences, and as these correspond with nearly all the intense rays of the sun, it results that the solar spectrum and that of the metal produced simultaneously on one plate, appear complementary to each other. I have not been able to determine the coincidences for cadmium rays, but six very intense rays appear to be found in the solar spectrum.

An important problem for spectral analysis, is to ascertain whether there exists a definite relation between different rays of the same substance, or still more between the spectra of analogous substances. I observed in 1863, that the three principal rays of sodium, seen for the first time by MM. Wolff and Diacon, are double, and that the two rays which constitute each group, are nearly at the same distance from each other as those of the double ray D. This appears to be a repetition of the same phenomena at different parts of the spectral scale, and the study of ultra-violet spectra, leads to many similar facts. I will cite the most simple. We know that magnesium gives, among other brilliant rays, a group of three green ones, coincident with the solar rays *b*, and I have observed in the ultra-violet spectrum of the same metal, two other remarkable groups. One of these situated near the ray L is sufficiently intense for the eye to perceive without difficulty, and is composed of three rays disposed in the same way, and at nearly the same distances as those of group *b*. These rays reappear precisely

* "Comptes Rendus," Aug. 2, 1869.

in the solar spectrum. The other group is situated between rays P and Q, and also reappears in the solar spectrum. It has the same form as the two first, but the rays are a little wider apart, which may be merely the result of the rapidity with which the deviations augment in this region under slight variations of the length of the wave. The least refrangible ray exhibits in these three groups the following numerical relations of wave length expressed in millimeters : 0·5182, 0·3864, 0·3335.

It is difficult to suppose that the repetition of such phenomena results from accident, and it seems natural to admit that these groups of similar rays are harmonics resulting from the molecular constitution of the luminous gas. It would, however, require a large number of analogous observations to determine the law which regulates these harmonics.

THE GREAT EARTHQUAKE OF PERU, 1868.

THE following particulars are taken from a report made to the French Academy by M. E. E. Gay, of the researches published in Spanish by M. Domeiko, grand master of the University of Santiago. It appears that in the night of the 13—14th August, 1868, the thermometer fell to a notable extent all through Chili, and that this was followed on the 15th by an equally remarkable ascension, having no relation to the normal temperature of the season. The barometrical indications were less decided, and unfortunately the magnetic observations of R. P. Capelleti were interrupted throughout the month. In 1835, during an earthquake in Chili, which overwhelmed the province of Concepcion, and destroyed many large towns, M. Domeiko was at Valdivia, and noticed a strong increase in the amplitude of magnetic vibration without the needle running mad (*affolée*). At the time he ascribed these movements to an austral aurora, but in a few days came the great earthquake, of which the shock was powerfully felt at Valdivia.

The earthquake of 1868 had its centre of disturbance between 16 and 18 degrees S. latitude, that is to say, between Arequipa and Arica, and in the direction from south-south-west to north-north-west. The shock, uniquely horizontal, was at first somewhat weak and almost noiseless, but it gradually augmented in intensity, so that in two minutes houses and churches were falling in sad commotion, filling the streets with their ruins; while the dust darkened the

air, and filled with consternation those whom Providence allowed to survive.

For many days the earth continued in convulsion, especially at Arica; and at Tacna, by the 17th they had already counted 180 distinct, although feeble, oscillations. The first shock occurred at Arica at 4h. 38m. in the afternoon, mean time; at Lima, 1040 kilometres distant, it was felt at 4h. 46m., and at 4h. 52m. it reached Copiapo, 1000 kilometres off.

The rapidity of wave transmission was thus considerable, and greater on the north side than on the south. By an approximate calculation, M. Domeiko reckons it at from 170 to 172 kilometres a minute on the Lima side, and from 125 to 130 on that of Copiapo. In this latter town, 27° 20′ S. lat., the motion was felt: but at Corrizal-Bajo, only one degree away from it, the inhabitants only felt a vague sensation, there being only a prolonged noise, without agitation of the soil. A remarkable fact is, that, notwithstanding the force and extent of the shock, it led to no elevation of the surface, unless in the nitre grounds (*nitrières*) of Peru, where fissures opened and water was spouted forth. The volcanoes did not show the least sign of perturbation, and this was the case in the Chilian eruption of 1835, notwithstanding the presence in the Cordilleras of some in activity. At that moment M. Domeiko was near Llanquihuc, which continued to pour out smoke without diminution or increase. The ground was upraised a little in some parts of the province of Concepcion, especially near Aranco; and rivers navigable for boats lost so much of their depth that they could be traversed on foot. Several perturbations took place in 1868 in the province of Imbabura.

The sea was agitated in 1868 by an eruption, so that the waves from it were felt from Acapulco to Chiloe, and from Peru to New Zealand, Sydney, and probably still further west. The waves had not the same force at all points of the coast. They were weak between Cobija and Mejillones, localities not far removed from the principal focus, and the same between Tongoi and Constitution; while, on the contrary, in Araucania they were violent between Caldera and Coquimbo, between Constitution and Aranco, and between Valdivia and Chiloe. These variations M. Domeiko attributes to the configuration of the coast. This opinion rests upon observations of MM. Godoy and Ochserrius, who noticed that all the bays open in the direction of the currents—that is, to the north-west—were but feebly disturbed if protected by a long promontory, while it was quite different with those which had no such shelter.

At Valparaiso, for example, the waves were scarcely noticeable, while at Constitution they produced disastrous effects. As might be expected, these waves were strongest near the centre of disturbance, and they were observed at different hours. At Arica they began at six p.m., while at Chiloe they were not felt till ten; and the next day (15th August) they reached Sydney and New Zealand, doing damage of some consequence. The sea currents were from seven to ten miles an hour, not differing from ordinary and constant ones.

M. Domeiko is still continuing his researches, and two government commissioners are engaged in drawing up a report. M. Gay speaks of this earthquake as one of the greatest submarine disturbances of the century, and states that he has read reports of subterranean noises heard a month afterwards at Talcahuano, and that the sea, in constant agitation, was so hot that shell-fish well-nigh cooked were thrown upon the shore.

ARCHÆOLOGIA.

On the occasion of the recent meeting of the British Archæological Association at St. Albans, Lord Lytton has caused to be opened a BARROW OF THE ROMAN PERIOD on his estate at KNEBWORTH. It forms a considerable mound, in a wood called Graffridge Wood (perhaps grave-ridge), separated from the far side of Knebworth Park by the public road, and somewhat more than a mile distant from the house. Two other barrows are found in the same wood, one of considerably larger dimensions, but further in the wood, and so overgrown with trees and bushes as to be less easy of access; the other, near the one opened, and originally of nearly the same size, but much diminished, and apparently lowered by attempts in former times to open it. A trench, about three feet wide, was cut from the side into the centre of the barrow, and laid open to view its construction in a very satisfactory manner. The body of the individual the mound was intended to commemorate had been burnt on a pile raised upon the level ground, until the body was consumed. The bones were then gathered together, and, no doubt, placed in an urn; after which, a larger mound of stones, chiefly flints, was raised over the remains of the funeral pile, so as to entirely cover it, and, finally, over this mound of stones was raised a much larger mound of sandy gravel, which constituted the barrow. In opening the trench the ground of

the outer mound was first cleared off down to the stones. The trench was then continued through the mound of stones until the excavators reached the original floor, which was found to be spread with charcoal and burnt materials, mixed, here and there, with very small fragments of human bones. All the central part of the mound of stones was now cleared out down to the floor, and almost to its extreme limit all round, in the hope of finding an urn; but neither urn, nor the slightest fragment of pottery, was met with, or even any of the large bones of the body. And from the extent to which the excavation had been carried, no hopes seemed to be held out that further digging would be more successful. This, however, is not a solitary case of the mound of this period being found without the urn, or any regular deposit of the bones of the body.

As the bones were no doubt deposited somewhere, it becomes a rather interesting question what has become of them when they are not found in the barrow? In the towns in Italy, where the burial-places lay outside the town, the family had often a mausoleum on the spot, with niches in the interior, or, as the Romans called them, *columbaria*, in which the urns containing the bones of deceased members of the family were placed, and they were no doubt visited at times by the surviving relatives, who, perhaps, held affectionate communion with them, or offered to them some mark of reverence. Many of these barrows no doubt were the graves of members of the families who possessed the great Roman villas which were scattered over our island, and it is not at all unlikely that the villa possessed within itself a private mausoleum in which the urns containing the bones of different members of the family were placed. The mound belonged to the spirit of the dead, and was supposed to be preserved and protected by it. Even other races, who subsequently occupied the land, looked upon it with reverence, or, at least, with dread, and there was no great inducement to destroy it. The barrow still remains undisturbed, but the urn and its deposit of bones have long perished with the villa and the family of which they belonged. It would be well to classify the barrows of the Roman period, distinguishing those in which the urns are found from those which have no urns, and some reason might be found which would help to explain the difference. Thus, the barrows without urns might be found to belong to a villa, while those in which the sepulchral urns are found might prove to have relation to some military or other station, where there was not the same convenience for the domestic mausoleum. On this, however, it would be unsafe

to give any decided opinion until the question has been more carefully examined.

It may be well also to remark that we intentionally speak of this monument, not as a Roman barrow, but as a barrow of the Roman period. The sepulchral barrow is, we believe, not found very commonly among the Roman monuments in Italy. It, perhaps, belonged to an older date than that of the high state of Roman refinement in which we best know that country. The Latin word for the sepulchral mound was *tumulus*, and every one acquainted with Roman poetry and legend is acquainted with the tumulus raised over the dead. Isidore, in his chapter on different forms of sepulchres (Etymol., lib. xv., c. 11), says that it was called a *tumulus* because it was "a lump or swelling of earth" (*dictus quasi tumens tellus*). Archbishop Alfric explains the Latin word in his Anglo-Saxon, "*Tumulus*, beorh," which is another form of the Anglo-Saxon word, *bearw*, represented in modern English by *barrow*. Some writers on this subject have therefore very unnecessarily objected to Roman barrows. In fact, barrows have been found in this country, the contents of which were undoubtedly and purely Roman. Such were the great mounds called the Bartlow Hills, in Cambridgeshire, on the borders of Essex. But it is perhaps more convenient to speak of these mounds less positively, and call them barrows of the Roman period. Britain was reduced to a Roman province and colonised by Romans, that is by Roman soldiers. Its society, as we know by the monuments, was Roman in form, and manners, and spirit, and language; in fact, it was perhaps, at first, in a great degree, Roman in blood. But that did not last long; the mass of the colonists were Roman soldiers, and as time advanced they were recruited, not from Italy (or much from Britain), but from all other parts of the Roman world. Thus, the occupant of a *tumulus* or *barrow* of the Roman period was only a Roman so far as being a Roman subject gave him that title. He may have been by race a German, or a Gaul, or a Sarmatian, or an African, or any other country under the Roman rule, and though the form of sepulchral interments presents a general uniformity of character, we cannot say how many of the sentiments of his own race may have entered into it. They were all Roman as to the outer world.

Perhaps connected with the subject of these barrows is that of the word WORTH as the termination of local names which occur so frequently in Hertfordshire. There are a number of Anglo-Saxon terminations of this kind, designating the residence or estate of the

chieftain or land-holder, which varied a little from each other in their meaning, or conveyed slightly different ideas, or perhaps belonged to different tribes of the same race. The most common, and perhaps expressive, was *ham*, the same word as our modern home, which designated, in fact, the home or residence of the family. *Burh* and *tun*, representing the terminations *-bury* and *-ton*, appear to have differed not much from each other, like the two words which have sprung out of them, *borough* and *town*, either represented a residence, or piece of ground enclosed by a wall or mound of earth, which the Anglo-Saxons understood by the word *wall*. The word *worth* appears to be applied with reference to the manor or land under cultivation, and to have resembled in its meaning the Roman *villa*. The glosses and dictionaries explain the Anglo-Saxon *weorð* or *weorðig*, as equivalent to the Latin *prædium*. The names of the Anglo-Saxon manor and estates were very usually derived from those of the earlier chieftans who possessed them, and in accordance with this classification, we find the *ham* most commonly combined with the patronymic of the family, not with the single name of the individual. Thus, *Birmingham* was *Beorminga-ham*, the home or head seat of the sons of Beorm, or of the family of Beorm; Cottingham is *Cottinga-ham*, the home of the family of Cotta. The *tun* is often found in the same combination as *ham*, as we find in such names as Wellington, *Willinga-tun*, the inclosed residence of the descendants of Wella. The *burh* resulting in the termination *bury*, and the *worth*, differ from these in being usually combined, especially the latter, with the name of the individual, as in the case of Knebworth, which can only mean the worth or estate of Cnebba,* and of Rickmansworth, or more properly Rickmeresworth, or the worth of Ricmere. We know from many facts that during the Roman period a large number of Roman villas were scattered over our island, evidently resembling in general character the Roman villas in Italy. We can have no doubt that the buildings of the villas were reduced to ruins by the barbarian plunderers, in the heat of the invasion, from the state in which we find the ruins, when we do find them; but when the Anglo-Saxons took possession of and settled upon the land, they cannot have failed to learn soon to appreciate the value and importance of the old cultivation, and to have adopted it as far as they

* The Normans went roundabout ways to represent the sound of the Anglo-Saxon and Danish *cn* or *kn*. Thus they called *Cnut*, Canute, or Kanute. And similarly in Domesday Book we find Knebworth spelt *Chenepa* worde.

were able. Why should not the new possessor and cultivator, when he took possession of the estate, adopt the ruined villa, and repair it or build a new one on its site, which probably presented the advantage of having the older farm-buildings, of whatever character they were, assembled on the spot. It has often struck us that the Anglo-Saxon *worth* was the real representative of the Roman villa, and that the Teutonic warrior here adopted the character of the old pre-Teutonic agriculturist. At Rickmansworth the remains of the old Bury, *burh*, or residence of the lord of the worth, are still to be seen; and Knebworth itself may perhaps occupy the site of a villa of the Romans, and then the three barrows near at hand may mark the funeral piles of three members of the family which held it.

On the northern side of the Thames, near to WALTON BRIDGE, are the remains of an extensive ANGLO-SAXON CEMETERY, which has long almost escaped the observation of our antiquaries. The ground has for many years been accustomed to be dug for gravel, and in the course of these operations skeletons, burial urns, vessels and fragments of other pottery, and, in some cases, of glass, fibulæ of different forms, weapons, and the other different objects usually found under such circumstances; but they were not taken care of, and have mostly perished long ago. The few still preserved from former discoveries are now scattered among a few private individuals, so as to be quite lost to science, and it is much to be desired that they should be brought together and deposited in a local museum. Among those we have seen are some fine examples of the Anglo-Saxon sword and spear, several very large umbos of shields, with the cross-pieces by which the hand grasped the shield, a bronze fibula, of the cross form, and two very interesting round fibulæ of silver, and some other articles. We were especially struck with the number of sepulchral urns, filled with bones, which were found among these remains, for urn-burial is considered to be comparatively of rare occurrence in the Anglo-Saxon burial places in the southern districts of England. A large portion of the site of the cemetery has, unfortunately, been already dug, but still some portions remain untouched, and it is very desirable that these should be all carefully trenched under the direction of some sound antiquary. Science, at all events, would be, no doubt, benefited by this proceeding.

The ABBEY OF CHERTSEY must have been very remarkable for its ENCAUSTIC TILES, with which the whole body of the church appears to have been paved, and which are found

in great abundance among the ruins of the floor, whole and in fragments. Executed with great taste and beauty, they are not ornamented in geometrical patterns, or in foliage, or in any mere decorative forms, nor did they form a series of religious or ecclesiastical subjects; but they presented a series of pictorial illustrations of some of the best known of the mediæval romances, and, that no doubt should be left of their meaning, each was accompanied with a description declaring its subject. One of the romances thus illustrated was that of Richard Cœur-de-Lion; another was that of Tristan; and others were taken from the romances of the Round Table. The pictures are drawn on circular tablets, which are inclosed in a band bearing the inscription, and surrounded with tracery of various kinds, and set in which were smaller tablets containing heads and various other subjects. An experienced and zealous antiquary of Chertsey, Dr. Shurlock, has given his leisure during some years to the collecting and studying of these tiles on the ancient site, and to preparing them for publication, and we cannot but look forward to their appearance, we hope at no very distant period, with great interest. They seem to be at present almost unknown. We cannot but think that the publication of these tiles, in a form calculated to be useful, accompanied with a careful text, would be a work altogether worthy of our Royal Society of Antiquaries.

T. W.

PROGRESS OF INVENTION.

STANLEY'S IMPROVED ELECTRICAL MACHINE.—In the usual glass plate electrifying machine, the plate is supported on a stand, and revolves between two stout uprights. Mr. Stanley has done away with these, and has substituted a very convenient arrangement which may be described as follows:—In the first place, two thin slips of wood brought close together, so as to allow only a space between them sufficiently wide to hold the glass, supply the place of the usual standards. These slips are united at one pair of ends so as to form a handle, by which the machine may be held without any other support, and is therefore portable, and may be used in a horizontal position. It will generally be convenient in accordance with this construction, to unite the other pair of ends of the slips of wood so as to form a clamp to bite the edge of the table, or a small perpendicular surface to press vertically on the table. In the second place, all apparatus connected with the rubbers is dispensed with, and the two slips, which take the place of standards, form also the base of the rubbers which are merely pieces of covered felt glued on the slips. Thirdly, the axle of the "plate-glass machine" is uniformly made of metal, here it is made of wood, which is cheaper and also a better insulating material. Fourthly, the glass plate in the ordinary machine is made of thick plate glass, but in this it is made of common sheet glass; hence there is a great saving of expense. Fifthly, with the above construction the remaining details are necessarily modified. The conductor is made of a simple ball, and a collecting comb, made of wire gauze, fixed by a glass or vulcanite stem upon the slips of wood, instead of the ordinary brass tube conductor. This arrangement is evidently extremely simple, and will, doubtless, be found very useful and accessible from its cheapness.

A NEW BITUMINOUS COMPOSITION.—M. M. Felice Labat and Joseph Meric, of Boulevard Bonne-Nouvelle, Paris, have discovered a means of manufacturing a very useful bituminous substance. It is composed of white or liquid resin, otherwise galipot, of lamp-black, and of sulphur and red sand. These ingredients are mixed in the following proportions:—

For every 100 lbs. of bitumen,

Sulphur	37½ lbs.
Galipot (or in case of necessity, colophony)	25 „
Lamp-black	12½ „
Sand	25 „

For bitumen to be applied to wood the quantity of sand may be reduced by about 5 lbs., and it is preferable that the wood be rough, that is to say, not planed. In preparing this bitumen the sulphur must first be thoroughly melted in a sheet iron caldron or earthenware pot, the galipot is then added, and when this has almost entirely melted, the lamp black is introduced, and lastly, the sand, and the whole is carefully

mixed over a moderate fire. This substance may be used in the shape of bricks, to be laid as a coating upon foundations to prevent the rise of damp. It is suitable for bottoms of reservoirs, for pavements of streets, for terraces, and for other such purposes.

WASHERS.—Mr. Philip Justice, of Philadelphia, has invented a new washer for nuts and bolts. It is made by cutting through an ordinary washer, so as to present taper edges, and allow of its being forced from the form of a plane to that of a helix, the object being, that when it is placed in front of a nut and screwed so tight as to again assume the form of a plane, the cut edges will act with such force against the nut and other part to which it is screwed, as to prevent the nut from turning round when violently shaken by railway trains or other means.

COATING SUBMARINE CABLES.—Mr. Henry Clifford, of Greenwich, proposes to protect the cores of submarine cables from the attacks of insects by coating, or serving them with powdered silica. The silica is made to adhere to the yarn or tape, which has been previously steeped in tar or pitch, the yarn or tape being afterwards wound round the core upon the outside of the usual serving of yarn. The core is afterwards surrounded by the usual outer covering.

WALENN'S IMPROVEMENTS IN THE ELECTRIC DEPOSITION OF COPPER AND BRASS.—By these improvements, it is stated that less battery power is required, and that the deposition is more perfectly effected.—A solution for the deposition of brass is made as follows: Crystallized sulphate of zinc (one part), and crystallized nitrate of copper (two parts), are dissolved in the smallest quantity of water possible. Sufficiently strong aqueous ammonia is added to precipitate these hydrates, and then dissolve them. After this, cyanide of potassium is to be added till the blue colour disappears. The solution should then be left to stand for a day or two, and may then be worked with from one to three battery cells (Smee's preferred), using heat if a brass anode be employed. The hydrated oxides of copper and zinc must be from time to time supplied, and, if necessary, ammoniuret of copper. Another solution to be used, where heat is required, but also applicable in the cold, with a porous cell arrangement, is made as follows: A solvent solution is first made, consisting of—

Cyanide of potassium (standard solution)		6 parts.
Nitrate of ammonium	do	1 part.
Sulphate of ammonium	do	2 parts.

The standard solution of each salt consists of the salt in the solid form dissolved in five times its weight of water.

The ingredients are mixed and the whole is divided into three parts.

Free solvent solution	1 part.
Solution to dissolve cupric cyanide . . .	5½ parts.
Solution to dissolve zinc cyanide . . .	2¾ parts.

When the respective cyanides have been dissolved to saturation in the

portions appropriated to them, the free solution is added, and the whole is thoroughly mixed; ammoniuret of copper is then added, and the solution is allowed to stand for a day or two. If a solution to deposit *copper* be required, instead of charging the solution with about one part of zinc to two parts of copper, the solution is charged with one part of zinc to ten or even twenty parts of copper. Mr. Walenn also includes in his patent an improvement which is applicable to all copper and brass solutions; it consists in the use of a porous cell arrangement, in which the surface of the solution next the zinc cell or other dissolving plate, is at a greater elevation than that of the external or depositing solution. He also renders alkaline copper and brass solutions free from the evolution of hydrogen gas, or nearly so, during electro-deposition, thus enabling the whole of the electric power, to be utilized, and a non-porous metal to be deposited. This he accomplishes by adding to either of the solutions above described, the hydrated oxides of copper and zinc, in sufficient quantity for the purpose, or by the simple addition of ammoniuret of copper.

EXTRACTING COLOURING MATTERS FROM STICK OR GUM-LAC.—This is effected by putting the lac into bags, and placing them between metal plates heated by steam, or in any other manner; these plates are then placed in an hydraulic press, the heat melts the gum, and the pressure causes it to pass out through the bags which act as a filter. The colouring matter is left behind in the bags. This process may evidently be applied to other matters than these gums, and with good effect. Mr. Henley, of Pimlico, is the patentee.

LITERARY NOTICES.

WHAT IS MATTER? By an INNER TEMPLAR, author of "More Light: a Dream in Science." (Longman and Sons.)—The author of this book tells us that "it would be the veriest hypocrisy in him if he said that he considered his efforts as a very *humble* contribution to science." He is bold enough to think that he shall overturn what have been considered as physical truths for hundreds of years; he has taken, he tells us, all that suited him from Thales to Kant, and he believes he has constructed an edifice that will defy the insidious workings of time, etc., etc. Expressions of this kind throw a doubt upon the complete sanity of their writer. He may, upon ordinary matters, know perfectly well what he is about, but his attempts at science appear like egotism run mad. So far as we can discover what the Templar means, we suppose he regards matter as *force*; and by conceiving it as force, he fancies he has got beyond phenomenal knowledge, and solved the great *noumenon* problem. He tells that "there is a single original element out of which all things are formed:

that this original element need not necessarily be gross matter: that matter consists of indivisible atoms: that these atoms do not require nuclei as well as forces, since the forces are sufficient to explain all phenomena, and therefore the atoms may be supposed to be simply forces." These "atoms have axes of motion and poles," and attraction and repulsion are sufficient to explain all phenomena. We are further informed that "matter acting on matter, is force acting on force, giving a resultant force, and that finite mind is essentially such a resultant force." If the Templar fancies that calling matter force explains what it is, or in any way advances knowledge beyond its every-day condition, it would be useless to point out to him that he is mistaken. It is idle to talk about coming before "a cold, keen, scrutinizing world" with words which are far from being the symbols of positive ideas. "Rays of light," he informs us, "consist of a continuous stream of atoms, travelling with different velocities, and revolving with different velocities upon axes at right angles to their line of projection." Though "so minute as to be beyond all power of weight," the author has no doubt they have a considerable influence in renewing the energy which is being continually expended by our globe, and he thinks they bring sodium and other materials from the sun. So far as the Templar's views are true or probable, they are pretty much in accordance with well-known opinions; but where he is original he seems to go wrong, and he thinks he explains everything, when, in fact, he tells nothing. No thinker in these days separates the ideas of matter and force. No one tries to conceive of matter which has no properties. We only know what we call matter, because we recognize force, and if we call it force, and drop the term matter, we are none the wiser, nor do we become so by transposing the terms, and saying matter is force, and force is matter. It comes to the same thing at last; we know only what the force *does*, not what it *is*.

Proceedings of the Academy of Natural Sciences. Philadelphia. No. I., January, February, March, and April, 1869.—This part contains "Notes on Microscopic Crystals, included in some minerals," by Isaac Lee, in which he states as the results of his observations on garnets from Bohemia, that in one hundred and fifty-four specimens he found forty-eight with acicular crystals, a larger proportion than that mentioned by Babinet. Pennsylvanian garnets yielded out of three hundred and ten as many as seventy-five, with similar crystals. Sixty specimens of cinnamon stones exhibited no such crystals, nor did the twenty-eight spinelle rubies. He conjectures the garnet crystals to be *rutile*. Amongst other papers, is one of some length and considerable interest on "The Cetaceans of the Western Coast of North America," by C. M. Scammon, United States, Marine, illustrated with figures of many species. Other papers relate to United States Miocene Fauna; Extinct Vertebrates from Wyoming and Dacota; and New Crinoida, and Echinoidia, from Carboniferous rocks of the Western States.

RECENT DISCUSSIONS ON THE ABOLITION OF PATENTS FOR INVENTIONS IN THE UNITED KINGDOM, FRANCE, GERMANY, AND THE NETHERLANDS. (Longmans.)—Mr. Macfie has, in this volume, republished his recent speech advocating the abolition of patents, together with sundry other speeches and remarks, all tending in the same direction. He is in favour of substituting state rewards, from ten thousand pounds to fifty pounds, or honorary notice, for really useful inventions. With much of his argument it is impossible to disagree, as no one can defend the patent system as it exists, and by which a vexatious monopoly is assigned to multitudes of individuals who do not really deserve one sixpence for their reward. Out of a number of patents, it will be found that a great proportion protect alleged inventions of no merit whatever, that another large portion assigns to the patentee privileges which ought not to have been granted, because although his plans may be useful, they are not sufficiently distinct from other known plans to merit any other reward than their inventor might make of them in the ordinary course of business. Nothing, for example, could be more absurd than a patent monopoly for distilling paraffin from one of the many shales, coals, or other minerals from which it could be extracted, and which any chemist knew the properties of. Finding a cheap supply of a known article is best rewarded by the usual action of trade laws, and the only legitimate monopoly in such a case would arise from purchase of the source, or sources of supply. Another class of patents is clearly objectionable, namely, those which have no practical completeness in themselves, but which are only aids to plans previously known, or which may have no commercial value until fresh discoveries are made.

Another class of objections to patents is that they do not effectually secure reward to those who deserve it. A poor man cannot defend a patent against a rich thief who wishes to steal it, and commercial and manufacturing morality offer little security against tricks of this kind; nor are inventors or the public protected against an opposite kind of fraud, as when a rich manufacturer wants to secure a monopoly for a patent that ought to be quashed, and he gets up a costly fictitious action, ending in a predetermined victory on his own side. Having got a decision, at great expense, others are afraid of attacking what he has unjustly gained. All this, and much more, may be said against patents; but, before abandoning them, the public must be satisfied that the system cannot be reformed, or that it is better to substitute something else. Some of the arguments of the anti-patent men are not valid. Thus, whether patents are contrary to free trade does not affect the question of whether or not they should be retained, because free trade does not represent an absolute law, but a system of expediency, and must not be confounded with that very different thing, equality of conditions. If, for a time, a slave-holding country can produce a given article cheaper than a free country, would opponents of patents therefore contend that

the manufacturer in the latter country should be allowed to steal labour under pretence of free trade?

Another specimen of anti-patent nonsense will be found in Mr. Stirling's paper, reprinted by Mr. Macfie, as when he says that because every thinker has the benefit of what other thinkers have done before him, he should have no exclusive privilege for his "infinitesimal addition to the work of ages." The man who labours with a spade in digging potatoes is also indebted to all the ages which contributed to the gradual formation of his iron tool; but, so far as his work is a personal contribution, he ought to be paid for it. An inventor is no more bound to give his brain-work for nothing than a digger to give his handiwork for nothin g and if ideas can be stolen more readily than labour, the act of stealing is not more praiseworthy. It is not by fallacious reasoning upon abstract principles, but by showing the failure of patents to answer their avowed objects of good, that the system of granting them must be effectually assailed.

The present patent system obviously cannot last; it is choking itself by its uncertainties and absurdities, but it is by no means easy to say how it should be replaced. In any consideration of what should be done, it must be remembered that an inventor is usually only the first of many runners who reach a certain goal, and that those who were morally sure to reach it soon after him ought not to be robbed for a considerable time of the profits for which they have toiled, by the grant of a patent to the man who has distanced them. If we preserve patents, we must regulate royalties, and neither allow patentees to refuse licences, or make monstrous charges for them.

NOTES AND MEMORANDA.

An Intermittent Lake.—The Lake of Zirkintz, in Carniola, is about ten leagues long and one wide. Towards the middle of summer, its level falls rapidly, and in a few weeks it becomes completely dry. At this time the apertures by which the water retreats can be distinctly seen; here they are vertical, there they are lateral, and directed towards the caverns with which the surrounding mountains are riddled. As soon as the water has retreated, the bed of the lake is placed under cultivation, and in a couple of months the peasants gather in their crop of hay, millet, or rye, on the spot where they had previously caught tench and pike. Towards the end of autumn, after the rains, the waters return by the same natural channels through which they departed. Some curious differences are observed in these openings of the soil, some furnish water only, others give a passage to water and fish of larger or smaller size, and from a third sort some ducks make their appearance from the subterranean lake. These ducks swim well from the moment they are thrown up. They are completely blind, and almost naked. The faculty of vision comes in a short time, but it is two or three weeks before their feathers—black except on the head—are developed enough to allow of flight. Valvasor who visited the lake caught a good many of these ducks, and saw the peasants fish for

eels, weighing from 1 to 2 kilogrammes, tench from 3 to 4, and pike from 10 to 15, and even 20 kilogrammes.—*Cosmos.*

The Stratification of Guano in the Chinchas.—M. A. Habel, reporting his travels in Tropical America to the French Academy, says:—"Up to the present time the guano has been considered as a simple accumulation of bird's excrement, but I found it regularly stratified, like sedimentary rocks, with layers of different colours, and various inclination and extension. Some layers for example, in one of the islands, have an inclination of 5°, and in another part of 15°. In one part of the southern island, I saw layers running from north to south, with an inclination of 4°, covered by others, from S.W. to N.E., with an inclination of 20°. Thus we can easily recognize two epochs in the formation of guano. While the lower mass, which is most ancient and most voluminous exhibits layers, the recent upper mass is thinner and without trace of stratification. Below the guano are layers of sand more or less mingled with it.

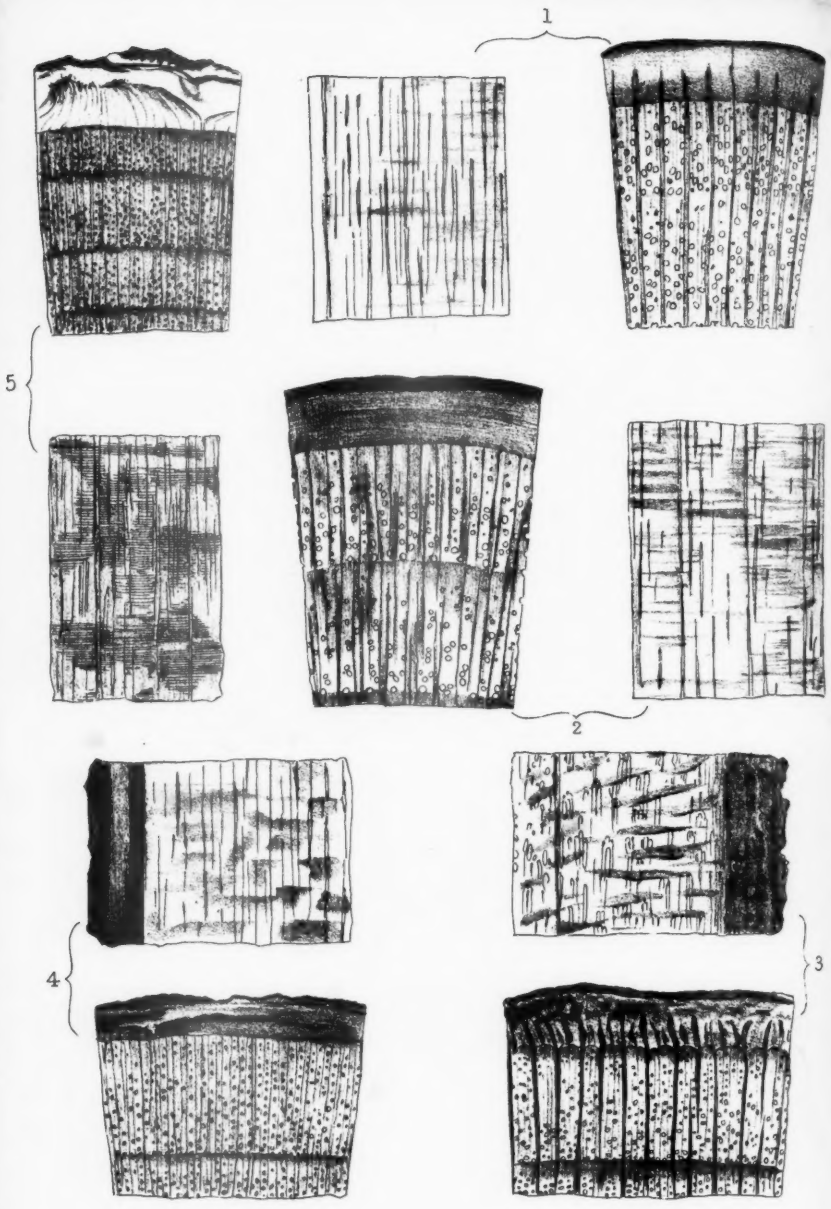
A Blood Spring.—M. Habel also states that he discovered in Equatorial America, a spring like that of Honduras, known as the *Fuente de Sangre*, the liquid from which resembles blood in decomposition.

Discovery of an Extinct American City.—M. Habel professes to have arrived at "complete success" in the study of Equatorial American antiquities, and he states that he found the ruins of a city more than three miles long, near the Pacific ocean. The sculptured monoliths, of which he promises to exhibit drawings, show a race different from the Aztecs. "Not only the costumes and the arms differ from those of the Aztecs, but likewise their religious rites; for the sacrifice of the Aztecs consisted in opening the breast of the victim, and tearing out its heart, while with these people it was accomplished by beheading." He states that he has collected vocabularies of nine Indian languages.

Chloride of Nitrogen.—Mr. Abel finds that if this substance explodes when its surface is in contact with the air, its effects are comparatively weak. A thin layer of water over it causes obstacle enough to develope its tremendous power, and a pressure of 5361 atmospheres is obtained.

Great Swarm of Lady-birds.—On Saturday and Sunday, the 14th and 15th of August, Ramsgate, Broadstairs, and other seaport towns on the south-eastern coast were visited by an extraordinary and interesting swarm of Lady-birds. In such numbers indeed did these small beetles suddenly appear, as in places to completely cover the objects upon which they rested. The sands, road, and footways were all swarming with these insects, and it was impossible to walk, without at every step, crushing numbers under the feet. So dense indeed were they at certain points as to form quite large red patches upon the stucco frontages of the houses, and upon examination it was found that nearly every railing was completely covered by them. Bathers reported that the sea also had its share, and that the quantities floating upon the surface did not add to the pleasure of the dip. The majority were of large size and of a dull yellow hue, appeared languid and weak, either from long flight or abstinence from food, and emitted upon touch a most objectionable odour. The swarm did not extend far inland, a short walk would soon show a perceptible decrease in the quantity, and at half a mile, no unusual number was observed. Even in the streets of London a considerable number of these insects were observed, and they have been unusually plentiful in the environs.

The Jamaica Nickel Coinage.—The coins described in our last number as made of pure nickel are made of nickel bronze. The error was accidental.



		Trans.	Long.
Longitudinal and Transverse Sections of	1. Cornus sanguinea, magnified	10 diameters,	.5 diameters.
	2. Rhamnus frangula	10 "	5 "
	3. Cerasus padus	5 "	5 "
	4. Viburnum opulus	5 "	5 "
	5. Euonymus europæus	10 "	10 "

THE "DOGWOODS" USED IN THE MANUFACTURE OF GUNPOWDER.

BY JOHN R. JACKSON, A.L.S.,

Curator of the Museum, Kew.

(*With a Plate.*)

THERE are few branches of science more subject to change than that which rules the conduct of warfare. Looking back but a very few years, we may easily trace such a revolution in the construction of gunnery and projectiles, that the results when considered seem somewhat startling. Such immense strides have been made both in gunnery and naval architecture, that it is difficult to say whether, except in scientific knowledge, we are in any way benefited by modern inventions in these branches of mechanism, for no sooner is some apparently invulnerable coating invented to encase our floating ocean monsters, than a gun is almost simultaneously produced to pierce its sides. The increased power of modern projectiles is due, more to the construction of the instruments themselves than to the composition of the combustibles used, for no new explosive agent has been brought into actual use to supersede gunpowder, so that gunpowder still holds its own, and its ingredients are identical with what they were in the time of Roger Bacon, who flourished about the middle of the thirteenth century, and died in 1292, and to whom has been ascribed its discovery, though there seems, great reason to suppose that it was known to the Chinese at a much earlier period. A Franciscan monk, named Berthold Schwartz, is said to have been acquainted with it at a very early date. One Ferrarius, a Spaniard, who lived in the thirteenth century, appears to have known it by the name of *flying fire*, and gives a receipt for its composition. Bacon was undoubtedly well acquainted with both its composition and its combustible nature, for he says, "A little matter about the bigness of a man's thumb, makes a horrible noise and produces a dreadful corruscation; and by this a city or an army may be destroyed several ways." Gunpowder seems first to have been used towards the latter part of the reign of Henry III., but perhaps it did not come into general use in England till early in the fourteenth century, or during the reign of Edward III.

Though, as we have already said, the chief ingredients of gunpowder are the same as they were six centuries back, many improvements have of course been made in its quality and composition, as for instance in the choice of the materials used, as well as in the

careful preparation and mixture of them. The charcoal is considered by the best makers the especial ingredient upon which the quality of the powder chiefly depends, so that much care is required in the selection of the proper kinds of wood to produce a good charcoal. It is to this branch of the gunpowder manufacture that we wish especially to draw attention. It may, however, be as well in passing, to say that much of the intensity of the explosiveness and consequent value of gunpowder, is due to three great causes—primarily, the purity of its ingredients; secondarily, a careful knowledge of the proportions; and thirdly, a perfect admixture of them.

With regard to the choice of the woods for gunpowder charcoal, oily or dense woods are always rejected, and the lighter kinds chosen. The woods which recommend themselves most for use with the gunpowder-makers, seem to be those most free from silica, and capable of producing a friable porous charcoal which burns quickly, leaving the least possible quantity of ash. After repeated trials of various woods, such as alder, willow, hazel, spindle, poplar, lime, horse-chesnut, and others, a wood known to the gunpowder makers as dogwood, was acknowledged to be the most suitable, and is now always used by the best makers for the superior kinds of powder. The history of this so-called dogwood is somewhat remarkable, inasmuch as it shows how errors are perpetuated by authors quoting one from another, and so handing down preconceived ideas which have obtained ground for want of proper and careful scientific examination at the first.

In most books relating to economic botany, or to the application of woods, *Cornus sanguinea*, or dogwood, is referred to as yielding the best charcoal for gunpowder. Certain it is that the gunpowder makers all know the wood they use in such large quantities, by the name of dogwood, and it was generally believed that *Cornus sanguinea* was the plant which furnished them with their supplies. Sometime since, however, a correspondence was opened between Dr. Hooker and one of the first gunpowder-makers in the kingdom, on the subject of the woods used in their trade. Specimens of these woods were sent to Kew, some were thoroughly dried and ready for calcining, others were freshly-cut specimens, and with these were sent branches with fruits attached, gathered from the same plant for the purpose of identification. These specimens proved to be not the wood of *Cornus sanguinea*, but that of *Rhamnus frangula*. Samples of the dried wood and a portion of a young tree were forthwith obtained from the Government powder-works at Waltham Abbey, the former from the stack of dried timber

kept ready for use, and purchased in the ordinary course of business, and the latter from the plantation round about the works. These specimens were found to be identical with those previously examined and obtained from the private works. After this, specimens were obtained of foreign grown dogwood, which upon comparison with those of English growth again proved identical; here then is proof that the *Rhamnus frangula* is the plant from whence the gunpowder-makers draw their supplies, and that *Cornus sanguinea*, or true dogwood, is never used now, nor, indeed is there any proof that it ever has been, for the powder makers maintain that what they now call dogwood is the same wood which has always been used by them.

It is but a few years since, that the bulk of this wood was supplied to the powder manufactories from English plantations, chiefly from Suffolk, Norfolk, Essex, and Kent; but after the introduction of the Enfield rifle into the military service of this country, the superior kinds of powder came much more into demand, and it was found difficult to obtain a sufficient quantity of dogwood. It was taken to the powder works in the winter of the year after the woods were cleared, the supply was very uncertain. A difficulty was likewise experienced in obtaining the desirable degree of uniformity in the length and thickness of the sticks, and the perfect clearing or scraping of the bark. Although the trees grow scattered about in most woods and plantations, it is only where the plants are grown in large quantities that the wood can be collected and sold with profit; further than this, the wood having necessarily to be perfectly free of bark, it must be collected either in the winter or early spring, when the bark is easily removed. And this spring cutting is objected to by owners of property, inasmuch as it disturbs the game just at the breeding season. All these things considered, the attention of one of the dealers in gunpowder woods was turned, some four or five years back, to the possibility of its importation from the continent, and a cargo of foreign dogwood was accordingly brought from Holland. This met with a ready sale, and since then the trade has rapidly increased, so that at the present time there are many firms established in Holland, Belgium, and Prussian Germany, who tender for the annual supply of this wood to the several gunpowder works in this country. Large tracts of marsh land and forests lying between Berlin and Frankfort, as well as in various other parts of the continent, have their undergrowth composed almost entirely of this description of dogwood, which can be obtained at a very low price.

The wood is delivered at the works in sticks, usually about six feet long, and about the thickness of a man's thumb, and tied up with strong wire into bundles about a foot in diameter. The powder-makers are very particular that the wood should be neither too fine nor too young, but of a medium growth. Crooked wood is also objected to as it will not pack well in the cylinders in which it is calcined. At the present time foreign grown dogwood is preferred before that of English growth, it is more even and regular, and better sorted, and besides this it is cheaper, for while the English product fetches, at the lowest price, about £10 per ton, the foreign wood is supplied at from £8 to £10.

The bundles of dogwood, as supplied to the gunpowder-makers, vary in size and weight according to where the wood is produced, and the wood itself also differs greatly in substance and density. Quick grown wood produced on a free soil such as that of Westphalia, weighs considerably lighter than that grown on poor soil, such, for instance, as Hanover. The standard measure of a bundle of dogwood used to be six feet long and two feet six inches in circumference, and such a bundle weighed from eighteen to twenty-one pounds. The foreign bundles, bound together with wire, are usually much larger, forty or forty-five bundles making one ton. The sizes of the bundles are so regulated as to be conveniently handled or carried about, and the above sizes are usually agreeable to the powder-makers.

Rhamnus frangula is a shrub growing from three to six or ten feet high, native of Europe generally, and grows, as we see it in England, in woods and thickets; the leaves are entire, oval, and the flowers whitish, five cleft, the berries are small, of a dark purple colour, and each contains two seeds. The plants will grow on almost any soil—as, for instance, in Suffolk, upon a low, sandy, or clay soil, or where the soil is composed of peat and rock, as at Sevenoaks, where, indeed, the wood is grown to some extent—why, then, the plants should not be more extensively cultivated in this country with a view to supplying our powder works with the produce of British soil, instead of having to send to the continent, is a question which seems worthy of consideration. As we have already seen, home-grown "dogwood" was at one time supplied to the powder-makers in sufficient quantities to meet their demands; but when those demands increased, attention was turned to the continent instead of to the question of increasing the home supplies by establishing plantations for the growth of the wood. It is said that English-grown wood is not so straight or of such regular growth as the

foreign, and that in some plantations in Prussian Germany the plants run up to a height of from fifteen to twenty feet, and perfectly straight. But there is no doubt that if the plants were properly cultivated with us, instead of being left to grow in hedges and ragged plantations, wood could be furnished of such a quality as to compete with the foreign produce. The principal question is with regard to price, for though much difficulty is often experienced in bringing the wood from the inland forests of Prussian Germany to the coast, and, consequently, a corresponding expense entailed, yet English soil is so highly cultivated, that few would think of growing the Rhamnus as a profitable crop. It might, nevertheless, be made profitable if cultivated in coppices, forests, woods, etc., and on much of the waste land which skirts our railways all over the kingdom. From the dangerous nature of the manufacture, gunpowder works are always more or less isolated, and the land immediately surrounding the buildings thickly planted with trees and shrubs to lessen the force of the concussion in case of explosion—thus, for instance, the Messrs. Hall's works at Faversham are spread over six hundred acres of land, and much of this land is planted with alder and Rhamnus, more especially the former, for though the wood itself is not so valuable as the latter for the actual manufacture of powder, the tree is, owing to its larger size, more effectual in obstructing fragments of burning timber as well as diminishing the force of the shock in case of an explosion. In some works it is the custom to stack the wood for a considerable period after being cut previous to using; thus, for instance, alder and willow would be kept for about three years, and dogwood for, perhaps, a still longer period. It has been found, however, that alder loses about twenty-five per cent. of its weight in the first month after cutting, and then remains stationary; therefore the system of stacking for so long a time appears quite unnecessary. From an examination of transverse sections of the woods of *Cornus sanguinea*, *Rhamnus frangula*, *Euonymus Europœus*, *Cerasus padus*, and *Viburnum opulus*, all of which are said to be used for powder-making—though I think it is doubtful whether the last two are used in any quantity—I have gathered the following results:—In the true dogwood, *Cornus sanguinea*, the annual rings are very distinguishable in the young wood, but much less so in the old, the medullary rays are very thickly placed together, appearing to the naked eye like mere lines. The wood, as seen under the microscope, is dotted over with pits or ducts more numerous near the outer margin of the concentric rings; it is hard and close-grained, and has little pith. The bark is

smoothish, of a brownish-grey colour, not easily separated from the wood when dry.

In *Rhamnus frangula* the lines of the rings are also distinct to the naked eye, each one showing, on microscopic examination, an edging on the outer margin of ducts rather thinly scattered about, those nearest the ring being the largest. The medullary rays are very fine and are less distinct than those of *Cornus sanguinea*. The wood is softer and much more easy to cut than that of Cornus. When freshly cut, the wood is throughout of an uniform yellow colour, but as it dries, the heart-wood appears to change to a decided reddish tinge. The bark is brown, marked with irregular longitudinal ridges composed of small fractures or openings, but having the appearance, to the naked eye, of minute transverse gashes.

In *Euonymus Europæus* the concentric rings are closer together than either of the preceding, but they are not so visible to the naked eye. The ducts or holes are small, and are very thickly placed on the outer margin of the ring, gradually diminishing in size and number as they approach the next ring. The medullary rays are very fine and are not distinguishable without a lens. The wood is of a yellowish colour all through, and much softer than that of either Rhamnus or Cornus. The bark is roughish green, with whitish longitudinal ridges, the inner bark silvery white, easily separated from the wood when dry.

In the bird cherry, *Cerasus padus*, the annual rings are marked by a distinct line, the whole surface of the section is dotted irregularly with small pits or ducts, the medullary rays are broad and very distinct under a lens, and the wood is hard and of a whitish yellow colour.

In *Viburnum opulus* or gueldres rose, the rings are marked by a faint line, the wood is studded over with small ducts, and the medullary rays appear like very fine lines, this wood is also hard and close grained, and when freshly cut of a light yellow colour.

Magnified drawings of transverse and longitudinal sections of each of these woods is shown in the Plate.

My aim in this paper has been not to give an account generally of gunpowder charcoal woods, but to draw attention to the fact of the apparently general application amongst the powder-makers of the term dogwood, to that of *Rhamnus frangula*; for while most botanical writers in mentioning this plant allude to the wood as being *one* of the best for powder charcoal, they do not apply to it the name dogwood, but refer that wood to *Cornus sanguinea*, which, I believe

has been generally, though it appears wrongly, accepted as furnishing the bulk of the wood used in the manufacture of the finer kinds of powder; alder, willow and other woods being still largely used for blasting and the coarser kinds of powders.

THE SEA-SIDE.

BY THE REV. THOMAS HINCKS, B.A.

An enterprising publisher has undertaken to furnish an answer to the question which, as each summer comes round, is eagerly agitated in many households, "Where shall we go?" But supposing this point to be satisfactorily settled and the mere locality decided upon, the equally important question, and one that seems to be rather a poser to the average Englishman, remains, "What shall we do when we get there?"

Our remarks apply to those who select the sea-side as their place of summer pilgrimage; and without unduly disparaging the ordinary occupations of the watering-place, we venture to think that they will bear to be supplemented and diversified by others of a higher character and interest. Those, at least, who do not find the stroll on the beach without definite pursuit, or the lounge on the promenade and the inevitable band, sufficient for their souls—to whom it is no relief to exchange the strain of business and the hard friction of the world for mere idleness and frivolity, will probably be glad to hear something of those aspects of the sea-shore that make it to the naturalist a great wonder-land—a perfect El Dorado of beauty that never wearies, and which, with all his keenness and cupidity, he cannot exhaust.

It is our purpose in this paper to indicate some of the sources of interest which the sea-shore offers to all who will seek them, and to give a slight sketch of a few of the many objects—"treasures the vulgar in their scorn reject"—which woo the idlest lounger on rock or sand, and would yield him delight and teach him wisdom, if he had but the key to their history. And first a word as to the different kinds of coast and their respective attractions. There is a peculiar charm about a fine sandy beach. Few things are more exhilarating than the breezy walk on a shore of this kind along the margin of the incoming tide, with the waves rolling freshly in, and ever and anon tossing the treasures of the sea at our very feet. Few things, on the other hand, are more deliciously soothing than to sit

on a calm summer's day and listen to the wavelets breaking with the gentlest laziest plash on the "yellow sands." But for the purposes of the collector the sands must yield the palm to the rocks. Like the museum the former generally offer us only dead specimens; for studies from the life we must seek the tide-pools, the clefts draperied with weed, the caves and crannies and chinks that pierce and furrow the rock-bound coast. Still the sands have an interest of their own; they are the home of certain tribes, they present a soft smooth surface on which the creatures that frequent the deeper water are cast without injury to their delicate organisms; they form the repositories of the spoil which the gale wrests from the sea, and hands over to the land. In good situations and under favourable circumstances the collector may gather a rich harvest by following the receding waters and overhauling the tangled masses of weed and zoophyte which they leave behind them. Those dark, unsightly rolls that so often strew the beach after a stormy tide are worthy of close examination, for many a curious form of life may be found in their recesses; many an exquisite coralline entangled amongst the great *Laminaria* belts and coarser strands of weed, or covering them with parasitic beauty. They should be seized as soon as they are borne within reach, rescued from the very grasp of the sea, and carried off to a safe distance for quiet study. Of course they may be barren and yield nothing but disappointment; the eye, however, soon learns to discriminate between the productive and unproductive, and a glance at the prevalent weed will generally suffice to show what fortune may be expected. Intermingled with the Algæ, which in form and habit of growth they closely resemble, some of the Hydroid Zoophytes are almost sure to occur, and may be at once distinguished from the surrounding weed by the horny character of their graceful arborescent shoots. Some of the larger kinds are amongst the commonest of sea-side objects, and certainly there are few more attractive. Their forms are full of beauty, and their history has the charm of a romance. Amongst the species which are most likely to occur, and are good typical illustrations of the tribe, we may name the graceful Sea Cypress (*Sertularia cupressina*); the Squirrel's Tail (*S. argentea*); the Sea Fir (*S. abietina*); the Fern Coralline (*S. filicula*), the bright straw-coloured masses of which, freshly stranded, are almost sure to attract notice; the Sea Hair (*S. operculata*), slender and wavy in habit, which comes ashore in long tangled tufts, or densely clothing some huge *Laminaria* stem; the Lily Coralline (*Diphasia rosacea*), the pearly white shoots of which, often furnished with tendrils like a climbing

plant, will be found overspreading the larger zoophytes; the Great Tooth Coralline (*Sertularella polyzonias*), which when living is of a pretty citron colour;* the Sickle Coralline (*Hydrallmania falcata*), one of the commonest of the tribe, graphically described by Sir J. G. Dalyell as consisting of "a series of feathers implanted in spiral arrangement around a slender stem," and, especially on the north and north-eastern coasts, the Bottle Brush (*Thuiaria thuia*), the trivial name of which gives a better idea of its general aspect than any technical description.

Most of the species now enumerated are inhabitants of deep water, where they cover with animal forests large tracts of the sea bed, and afford shelter to many tribes. After rough winds they are often cast ashore in immense quantities, while the nets of the trawlers who carry on their work largely in the coralline zone come up laden with them, draperied and festooned with their light and elegant forms, and at night illuminated by their phosphoric fires. On the sands we only gather for the most part the skeletons of the zoophytes; we find them torn from their attachment and deprived of much of their beauty, and yet beautiful still. Here is a tuft of the Sea Cypress, or rather the horny, ramified, tubular case, which incloses and protects the soft fleshy portions of the animal. The tall central stem is clothed with fan-shaped branches, pearly white and semi-pellucid, somewhat spirally disposed and drooping gracefully round it; these branches decrease in size towards the upper part of the shoot, which terminates in a long tapering spire. The full beauty of the form will be most apparent if the specimen is immersed in water.

The shoots of this fine species are sometimes two feet long. Imagine such an one in vigorous life, rooted to some shell or stone lying thirty fathoms deep. Its history may be epitomized in a few words. The branching tubular case, that constitutes the elegant plant-like shoot, is, as it were, the *cast* in horn of a living flesh which pervades it throughout, penetrating into every minute ramification—the basis and essential portion of the structure. At definite intervals this common flesh gives origin to minute beings (*polypites*) which resemble the well-known *Hydra* in structure, and constitute the feeding organs of the commonwealth. The polypites are lodged in

* The colour is of short duration, depending on the presence of the fleshy pulp pervading the whole structure, which soon perishes. Masses of this species "when freshly cast upon the shore, and before the evanescent colour has faded, have a certain exquisitely delicate beauty, and may almost be said to glitter on the dark heaps of seaweed."

cup-like dwellings (*calycles*), which are set along the sides of the branches, and give them their serrulate appearance. Each of them consists of a stomach with an oral aperture, and a wreath of contractile tentacles encircling it, which now expands above the orifice of the calycle, and now is folded together and packed away within it. The legions of Hydræ are continually engaged in capturing and digesting food, which when prepared they pour from a thousand stomachs into a central canal pervading the common flesh, by which it is distributed to every portion of the colony, nourishing it and building it up. Fed by the unfailing supplies of aliment thus procured the zoophyte puts forth its vegetative energies, and throws out fresh branches and branchlets, bearing new companies of Hydræ, until it has attained its full proportions. At certain seasons it takes on the reproductive function; along the branches elegant horny capsules, reminding us of the seed-vessels of the plant, make their appearance, in which sexual buds, male and female, are produced, that originate the seed of new colonies. The stationary animal has its active locomotive embryo, which after a short term of free life attaches itself, and evolves a single hydra, from which by repeated gemmation the composite and plant-like organism is developed.

The Sea Cypress, then, is a vegetative animal with a many-hundred stomach power; it multiplies its hydræ as the tree its leaves; it casts forth its ciliated embryos, ten thousand at least from a single shoot in the season, as the plant scatters its winged seeds. It is a true animal, curiously imitating the form of the plant, and reproducing in many ways the fashions of its life.

Another interesting tribe will almost certainly have its representatives amongst the rejectamenta of the tide, which, while structurally remote from it, bears in many points a striking likeness to the Hydroid. Increase to an indefinite extent by budding is as characteristic of the *Polyzoa* as of the zoophyte; they too are composite animals, often plant-like in form; they consist of many individuals (polypides), each protected by a cell-like dwelling, united together in one organism; and the polypide has a certain superficial resemblance to the hydra. There is no essential relationship however between the two tribes, the Polyzoa being connected by structural affinity with the Mollusca. They offer much to attract the collector and interest the student. In the first place they are numerous on our coast; parasitic on weed and zoophyte, attached to shell and stone and almost every marine substance, they occur in immense profusion and variety. They

exhibit great elegance of form and beauty of minute sculpture, while the structure of the polypide and the wonderful mechanism of the cell are of the highest interest to the microscopist.

Scarcely a mass of weed and zoophyte can be examined which will not yield some members of this tribe. Their little bushy tufts—some bristling with spines, some like delicate carvings in ivory, some studded with the pearly ovaries, and all as unlike the animal forms with which we are most familiar as possible—greet the collector at every point. Many of the plant-like kinds are calcareous, every shoot consisting of a series of cells linked together, and disposed in a single row or in several; and each cell having its orifice, through which the polypide protrudes itself at pleasure, and spreads forth its wreath of ciliated tentacles. Other stony species consist of collections of tiny tubes, supported on a circular saucer-like base, and looking like petrified little flowers; others form a delicate net-work on the surface of shells and stones; others again occur as spreading crusts, which when examined resolve themselves into a multitude of minute cells laid side by side, and often richly sculptured. Some of the Polyzoa are fleshy or gelatinous in substance, and some horny. But the composite structure, the aggregation of a number of cells, each containing a polypide with ciliated arms, is characteristic of the whole class.

There are few sandy beaches that will not yield the common Sea Mat (*Flustra foliacea*), and there is no better example of a Polyzoon. Many a time and oft it is trampled under foot by the idle lounger on the shore, who would be thankful for something to relieve his *ennui*; or it is carelessly looked at as a strange "weed," and as carelessly flung away. But it is a structure to wonder at. You pick up a bunch of it freshly cast in by the tide. You have a population of some thousands in your hand. Every inch of the Mat is covered with cells on both sides, their apertures guarded by spines and covered in by a moveable lid; and stowed away in each one of them is a being of exquisite organization. There is no sign of life now; but place the *Flustra* in sea water, and if it be still living, you will soon see tenant after tenant start from its little dwelling and spread forth its wreath of tentacles, within which seethes an eddying whirlpool, a very Charybdis to the passing animalcule, and with a Scylla close at hand. And to begin at the beginning, the great mass which we are examining, with its many square inches of surface and its population of thousands, had its origin in a single cell, from which by repeated buddings it has been gradually developed.

The touch of science is in one respect at least like that which changed everything into gold; it converts the commonest objects into things of beauty and wonder.

The Heart Urchin (*Amphidotus cordatus*), is a familiar representative of the great tribe of Echinodermata, comprising the Star-fishes, Echini, and Sea-cucumbers, and often strews the sandy beach by hundreds. The frail shell that protects the soft portions of the animal, and which we trample so thoughtlessly under our feet, is a masterpiece of construction. It is not, as might be supposed on a casual inspection, formed of a single piece, but of a multitude of minute calcareous plates, all pentagonal—for *five* is the dominant number of this class, ruling the very details of its structure—and all fitted together with perfect accuracy. We may dissect the shell of the Urchin, resolve it into hundreds of pentagons, and lay out all its component elements on the flat, just as we might deal with the bricks of a house. And in the living state, the mortar that holds them all together is a membrane which involves each one, and which not only maintains the integrity of the structure but provides for its symmetric growth. For as the soft body within enlarges, the stony box enclosing it must enlarge also and without losing its spherical proportions; and this problem is solved by means of the composite structure which we have described. The living film which penetrates into the interstices of the organic masonry, deposits simultaneously and uniformly fresh stony matter along the edges of *each* plate, and so the shell gradually swells out without losing its shape, to meet the increasing demands of the tenant within.

The spines that clothe the shell, and are so characteristic of Echinodermal structure, are organs of locomotion and instruments for burrowing. They are not rigid appendages, but can be moved freely in all directions, and their mobility is secured by a very admirable contrivance. If the shell is examined, when denuded of its spines, it is found to be thickly covered with minute rounded prominences. Each plate bears a number of them, and to every one a spine has been articulated, supplied with an efficient muscular apparatus, and playing freely on a true ball and socket joint. By means of this elaborate mechanism the urchin propels itself or conceals itself in the sand. But it can scale rocks as well as burrow and traverse the level ground, and for this purpose another and very different set of instruments is needed. It may be noticed that one region of the shell is perforated by numerous minute orifices, which are disposed in radiating lines; through each of these, in the living state, an extensile tube can be protruded, capable of immense elongation

and terminating in a powerful sucker, and by means of these suctorial feet the urchin can climb the most precipitous rock, or moor itself securely to its surface. These organs can be studied to great advantage in the common star-fish. Our idle loungers on the beach, without aim or object, might find good companionship, we venture to think, with the Echinus, and relieve their tedium not a little in his society.

Of course the sandy shore is the hunting ground of the shell collector, but the sport is uncertain, and for the most part only the commoner kinds can be obtained without the use of the dredge. Near low-water mark some of the burrowing molluscs (Mactræ and Razor-shells) may be met with, their presence being indicated by a small mound on the sand or a funnel-shaped depression. The rapidity with which the latter work themselves downward by means of the muscular, spade-like foot with which they are furnished, is such that the fishermen are compelled to resort to stratagem when capturing them for bait. Occasionally a piece of drift wood is stranded on the beach, and is always worthy of examination. If it has been long in the water it will probably be covered with zoophytes; or it may be pierced by some boring mollusc, such as the famous Teredo, which helps indeed to clear the ocean of dangerous lumber, but has also sunk ships, destroyed piers and bridges, and obtained a place in history by endangering the safety of a kingdom.

Few sea-side objects attract more general attention than the large "blubbers" or jelly-fish, which, especially in autumn, are cast in immense numbers on the sands. Lying helplessly there, mere unsightly masses of film and fluid, they give no hint of the beauty of the living creature, as it floats gracefully in the water, or propels itself by the pulsations of its umbrella-like disc. These large jelly-fishes (*Discophora*) are essentially oceanic in their habits, and frequently in calm weather occur in immense shoals which cover extensive tracts of the sea. They are related to the hydroid zoophytes which we have described before, and though vagrant for the larger portion of their life, they originate by budding from a fixed polypite stock, which is found attached to shells and stones. They are in fact the reproductive elements (zooids) of a zoophyte, that bears a general resemblance to the *Hydra*; floating nurseries in which the ova are borne and hatched, and from which the young are turned adrift, at the proper time, as active, ciliated embryos. The jelly-fish is not to be regarded, therefore, as a perfect whole, but rather as one element of a complex individuality; the detached

flower-bud, as it were, of a vegetative animal. The *Discophora* are the most unsubstantial of beings, and bulky as they look and are, soon dissolve away and leave no residuum but a quantity of fluid and a little membrane.

On shores exposed to the Atlantic and after the prevalence of certain winds, other ocean-floaters may be met with. A whole fleet of *Velellæ* is occasionally stranded on the beach, as we have seen it on the fine reach of sand below the pebble ridge at Westward Ho, the little voyagers having been drifted from the open waters to which their entire organization is adjusted, and flung helplessly ashore. A yet rarer waif is the Portuguese Man-of-War (*Physalia*) which is driven to our coast at times, under stress of weather, from higher latitudes. Landing on Lundy Island one summer day, we were fortunate enough to secure a specimen that had just been lodged uninjured in a pool amongst the rocks. A sailor who incautiously attempted to seize the prize with naked hand was severely stung, and received a practical lesson on the habits of the "Sea-nettle," which he was not likely soon to forget.

Occasionally we encounter small masses of jelly, lying like little crystals on the sand; these are never to be passed without examination. They will generally prove to be Medusæ (so-called), or the exquisite little *Beröe* (*Cydippe*), which on being removed to a vessel of sea-water will delight us by its graceful movement, the translucency of its crystal globe, the rapid play of its ciliary paddles, irridescent in the sunlight, and at night by its phosphoric glitter.

But we must hasten to the rocks, the richest collecting ground, and one that is independent of the chances of wind and tide. The space between tide-marks may be divided into zones, characterized by different productions both animal and vegetable. The lowest rocks are the most interesting, but each range has its own attractions. We must interpose a caution, however, before proceeding to indicate some of the things that may be found. Many of them will not reveal themselves to an untrained eye or to a careless search. The art of collecting is not learnt all at once, and at first the very ground which is rich in hidden treasure may seem to be unproductive and devoid of interest. The work will not yield much if it is done in a lounging, dilettante way, with gloves on or too good a coat; he who would really succeed must not be above sprawling on the rocks, if need be, or plunging his bare arm into the recesses of the pool, or poking his head into the cleft amongst the dripping weed.

But to the rocks.—One of the first objects that may probably

attract attention, for it is found on all coasts and in the most accessible situations, is the common red sea-anemone (*Actinia mesembryanthemum*). It occurs profusely on the upper rocks, and when left by the water appears as a small, smooth fleshy mass, which like the bud of the plant gives little intimation of the beauty hidden within. In the rock-pools it may be seen in full bloom, its many wreaths of red tentacles surrounding the central mouth, like the parts of a compound flower, while the base of the outermost set is girded by a ring of brilliant turquoise-like tubercles. The species is not in its common form remarkable amongst its kindred for beauty, though one of its varieties, the well-known *Strawberry* of collectors, vies with most of them in this respect, and is a fine example of an "animal flower." The red anemone, however, though not one of the handsomest, is one of the most familiar of its tribe; and is a good typical illustration of the large and important order (*Zoantharia*) to which it belongs.*

We have not much to say of the *Actiniæ*, though they cannot be omitted in any sketch, however slight, of the fauna of the rocks. From their brilliant colours and the number of varieties found on our coast, they are favourites with the amateur collector, and of late years have acquired much popularity as the pets of the aquarium. Their forms and colours remind us of the flower, and they certainly contribute an important element to the scenery of the submarine gardens. Pleasant it is to look down into the clefts or gullies amongst the rocks, as the tide begins to fill them, and watch the large *Tealia crassicornis* (the familiar "Crass" of the aquarium) expanding, blossoming into full beauty, changing from a dirty-looking heap of broken shells and stones into the semblance of a splendid double flower; or to look into the small upper basins, and see the "Daisy" clustering in the chinks and crannies, and covering the bottom with its festooned disks; or to admire the sociable *Anthea*, with its velvetty green tentacles tipped with rose, fringing the edges of the pools; or the brilliant "Gem" studding the floor of some miniature lake.

The *Actiniæ* suggest to us the glories of tropical seas, and may enable us to realize, in some degree, the gorgeous spectacles which are presented by the Coral reefs. Seated beside some flowery pool, imagine one of the anemones before you endowed with the power of secreting in its tissues a stony skeleton; and further, of budding

* The Cœlenterate sub-kingdom (including the zoophytes generally) has its two classes, *Hydrozoa* and *Actinozoa*, and to the latter belong the sea-anemones, the coral-making polyps, the sea-fans and pens, and the charming *Berŏe* and its kindred.

off, like many of its kindred, other anemones, which instead of becoming separate, solitary individuals should continue organically connected with it; and imagine these again surrounding themselves in the same way with other systems, until a continuous crust should be formed—a stony framework invested by a living flesh, thickly studded with anemones or polyps, and brilliant with many colours. Let us imagine all this, and we shall have an idea of the structure and growth of the coral-mass. The coral-making polyps are in fact sea-anemones with stone in certain of their tissues, and multiplying in most cases by continuous gemmation, so as to form composite, instead of solitary animals. A few coralligenous species occur on our coasts, but they are small and simple. At certain points, where the genial influence of the gulf-stream is felt, the little madrepore (*Caryophyllia Smithii*) shows itself, and may be chiselled off the ledges at extreme low-water mark. The chisel and hammer are essential tools to the collector of the Actinozoa, who will find it no easy matter even with their aid, to detach the Anemones from the rocks to which they fix themselves with extraordinary tenacity by means of their adhesive disks. And, indeed, unless they are wanted for the aquarium or for special study, why not admire them in their native haunts, rather than run the risk of destroying the flower in the attempt to pluck it?

The beauty of the rock-pool has often been celebrated both in prose and verse. It would be difficult to say too much of it. In exploring the rocky space between tide-marks, we are continually arrested by the exquisite scenery of some little grotto, some "fairy paradise," the walls of which are clothed with dense forests of delicate Algæ, exhibiting a glory of colouring, autumnal in richness and variety—reds, browns, olives mingling with the most diversified shades of green, while the floor is studded, it may be, with the brilliant sea-flowers, and breaking the monotony of mere still life the glittering little fishes flash from side to side. To realize fully, however, the beauty of the tide-pool we must examine its detail. There is an extraordinary variety amongst the Algæ; some presenting the most exquisite feathery forms, some growing in thread-like tufts, some streaming up like ribands through the water, some displaying their broad and tinted fronds, like banners. And amongst the weed in these sheltered retreats are always to be found some of the plant-like zoophytes to which we have referred before.

Some of the smaller *Plumulariæ*, compound animals which curiously imitate the shape of the feather, may generally be found

overspreading the rock amongst the weed, or covering the stems and roots of the larger Algæ. It requires a practised eye to detect their delicate forms in the midst of the rank jungle which often surrounds them; but if slices be pared off the surface of the rock with a strong, flat knife, and placed in a bottle of sea-water, they may be examined at leisure with a lens, and in this way many curious and beautiful things may be obtained. The *Plumularia* is worthy of special notice, as it is readily found, and well illustrates both the general structure and the beauty of the hydroid zoophytes. A number of plumous shoots spring from a delicate creeping fibre which overspreads the rock, and binds them all together in one compound organism. Each plume is a horny tubular case pervaded throughout by a thread of animal substance; along the pinnæ are set a number of minute cup-shaped receptacles (calycles) in each of which is lodged a *Hydra*, and all the Hydræ are bound to the central flesh, and all co-operate in capturing and preparing food for the nourishment of the commonwealth to which they belong. Like the myriad leaves on a tree, they are all members of one composite being, sharing and subserving a common life. And the zoophyte, like the tree, increases by budding; the *Plumularia* puts forth through the seasons fresh branches and fresh Hydræ, and rooted amongst the Algæ lives a life as vegetative as theirs. The rock-pools will also yield other hydroids; the *Coryne* or *Syncoryne*, the hydræ or polypites of which are not protected by a horny cup, but are furnished with knobbed tentacles scattered over a clavate or cylindrical body; the *Campanularia*, which presents us with elegant little crystal goblets mounted on ringed or twisted pedicels, the homes of milk-white Hydræ, that spread forth their embossed tentacles over the margin in search of prey; the tree-like *Obelia*, whose pellucid shoots support multitudes of campanulate calycles, exquisite in form and transparent as glass, and many another which will prove an ample reward for the labours of the collector.

Encircling the stems of the larger sea-weeds in the same pools a gelatinous crust will often be found, bristling with spines. It is extremely common, but like many other things of great intrinsic beauty and unattractive exterior, it may be passed over as unworthy of notice. We recommend every collector to look for it. It is one of the Polyzoa or Zoophytic Molluscs before referred to (*Flustrella hispida*); the gelatinous mass is a compound animal; lodged in its substance are a multitude of cells, which open on the surface, the orifice being marked by several spines; each cell has a

tenant (the polypide) structurally related to the mollusc, but reminding us in many respects of the Hydra of the zoophyte. It has its wreath of ciliated tentacles which expands above the orifice of the cell, and in gracefulness of form is unsurpassed. It presents a campanulate figure, the margin being most elegantly everted; the curves are perfect, the eye recognizes in the shape a faultless beauty. Multitudes of these bell-shaped crowns of tentacles cover the common mass, whilst the polyzoon is in full health and vigour, and it has then the appearance of being enveloped in a bluish mist or vapour. The slightest alarm causes the polypides to retreat into their cells; they vanish in a twinkling, like Roderic Dhu's warriors, and where one moment there were hundreds of the exquisite bells, the next there is nothing but the rough brown surface of the crust. In the clear still water of the rock-pools, the blue mist may often be seen by a quick eye hovering over the masses of *Flustrella* on the weed.

Looking down into the clefts that furrow the rocks, and under the overhanging ledges, one is struck by the brilliant colouring that meets the eye. This is mainly due to the various kinds of sponge that overspread the rock, and like the lichens, which light up the sombre stone walls and the dark trunks of trees, relieve the dull tone of colour in these "sunless retreats." In the same situations, the bright flower-like heads of the *Tubularia*, borne on long tubular stems, are often to be seen, making the rock gay as the parterre of a garden; and the large sea-slug (*Doris*) hides in the chinks; and the tube-dwelling worms display their gorgeous crowns; and the boring molluscs squirt water from their burrows in the rock, and the sea-stars stud its surface; and on all hands there is life in "rare and beautiful forms."

We make our way down to the tangle-beds which fringe the lowermost rocks, and see the little pellucid limpet, with its brilliant blue lines, glittering like a jewel on the dark ribands; the delicate forests of zoophyte (*Obelia*) spreading over them; and about their roots a swarming population, of which we have not space to give the census. These tangle-roots should be torn from the rock, and separated from the fronds and reserved for quiet examination. They are rich treasuries to the zoologist.

Then there are the delights of *stone-turning*, only known to the naturalist—but we must pause.

These slight sketches must be accepted as a mere indication of the *sort of interest* which the sea-shore will yield to those who have an eye for the details of nature, as well as for its grander features and general effect.

THE MOHAMMEDAN HISTORY OF EGYPT.

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CHAPTER II.

EGYPT UNDER THE CALIPHATE.

In order to understand the position of Egypt under the Mohammedan rulers, it will be necessary to review briefly the history of the Caliphs or successors of the Prophet. On the death of Mohammed, on the 8th of June, A.D. 632, a dispute arose as to the appointment of his successor, which resulted in the election of Abu Bekr, surnamed Es Sadík, the father-in-law of the Prophet, and one of his earliest converts. As soon as Mohammed was laid in the grave, Abu Bekr and 'Omar ibn el Khattáb proceeded to the house of some of the Ansárs* and Muhájérín to deliberate upon the emergency. A warm altercation ensued, in the course of which it was suggested that two caliphs should be appointed to represent the rival interests of Mecca and Medina, but 'Omar foreseeing the danger of originating two such factions at the very outset of the undertaking, solved the difficulty by proclaiming Abu Bekr caliph, and his example was presently followed both by the Ansárs and the Muhájérín. On the following day his accession was made publicly known, and he proceeded at once to enter upon the active duties of his office. Abu Bekr died after a short but brilliant reign of little more than two years and three months, and was succeeded, A.D. 634, by 'Omar ibn el Khattáb, to whom he had himself bequeathed the Caliphate. This 'Omar was the first to assume the style and title of *Amír el Mu"minín*, or Chief of the Faithful, and it was at his suggestion that his predecessor had undertaken the official recension of the Corá'n, which had hitherto existed only in scattered and disjointed fragments. A war against Syria which had been commenced by Abu Bekr, was prosecuted by 'Omar, and brought to a successful issue. His general in that country was 'Amer ibn el 'As, and him the Caliph instructed to undertake the expedition against Egypt mentioned in the last chapter. Whilst this officer was on his road thither, a messenger from 'Omar overtook him, to inform

* This title, which signifies "Assistants," was given to those of Mohammed's followers who were inhabitants of Medina, as having assisted him in his flight to that city. The Meccan or Coreish Muslims were distinguished by the name of Muhájérín, or "Companions of the Flight."

him that he had been superseded in the command. The Caliph's letter required 'Amer to return at once, unless he had actually entered the Egyptian territory, but suspecting the nature of its contents, he carried it with him unopened until he had passed the Syrian frontier, and so evaded the injunction to return. The circumstances of his invasion have been already detailed. The introduction of the Mohammedan form of religion and government, naturally produced a complete revolution in the manners and customs of the country, all the ancient Christian and Pagan observances being unsparingly swept away. The following story, religiously believed by the Muslims, may be considered as a traditional crystallization of this fact. It had been a custom with the Egyptians from time immemorial to sacrifice every year a beautiful virgin to the Genius of the Nile, the river refusing to rise until a suitable victim had been provided, decked out in her richest attire, and thrown into its stream. 'Amer ibn el 'As would not countenance this horrid and heathenish rite, and accordingly no inundation took place at the accustomed season in the first year of his governorship. When two months had elapsed without any sign of relenting on the part of the offended river, and the inhabitants of the country seeing no prospect but that of famine before them, were preparing to emigrate *en masse* 'Amer ibn el 'As wrote to acquaint the Caliph with the circumstance, and to ask his advice in so perplexing an emergency. 'Omar in reply sent him the following letter, which he requested him to throw into the river in place of the accustomed human offering :—

"In the name of God, the Merciful, the Compassionate,

"From 'Abdallah, the Chief of the Faithful, 'Omar ibn el Khattáb to the River Nile greeting—

"If thou dost flow of thy own pleasure, then flow or not as thou listest now. But if it be the One Mighty God who causeth thy waters to flow, then we ask that God to make thee rise."

This note 'Amer threw into the Nile, and the Egyptians were delighted the next morning by a visible increase in the height of the waters, which continued to rise until the fertilization of the country was complete.

A relic of the custom here alluded to, of sacrificing a virgin to the Nile, exists in a curious ceremony still practised in Cairo, at the time of the inundation. A round pillar of earth, in the form of a truncated cone is placed upon the dam constructed at the entrance of the Khaleeg or Grand Canal. This pillar is called *'Arúset en Nil*, "the Bride of the Nile," and is always considered a necessary preliminary to the opening of the canal.

'Omar was assassinated, A.D. 643, by a Parsee named Fírúz, who considered himself aggrieved at being compelled to pay an extra daily tribute for the privilege of practising his own religion. On his death 'Othmán ibn 'Affán was nominated Caliph. He, disregarding the signal services of 'Amer ibn el "As removed him from the Governorship of Egypt, and appointed in his stead, one 'Abdallah ibn Abi Sarh, who seems to have had no other qualification for the office than that of being one of 'Othman's private friends. His election gave great offence to the Egyptians, who desired to have Mohammed, the son of Abu Bekr for their prefect. This led to numerous complications and much dissatisfaction against 'Othman, and the ill-feeling being fostered by 'Ayeshah, the widow of Mohammed, and Merwán the prime minister, ultimately resulted in the Caliph being barbarously murdered, A.D. 655, at the advanced age of 82.

On his death the Ansárs and Muhájérín requested 'Alí ibn Abi Táleb to accept the Caliphate, to which after some hesitation he at last consented. He also was treacherously murdered, A.D. 665, in Cúfah, which he had made his capital. His reign, which lasted little more than five years, was disturbed by numerous revolts, the most formidable being those brought about by the intrigues of Moa"wíyeh and 'Amer ibn el "As. 'Alí had sent Sad ibn 'Obádeh el Khazarjí into Egypt as governor during the early part of his Caliphate, but on the representations of Moa"wíyeh was induced to recall him, and appoint Mohammed, the son of Abu Bekr in his stead. This led to fresh troubles and dissensions, as Mohammed showed himself violently hostile to all whom he suspected of friendship or partizanship with Othman's family. Ali was in consequence compelled to order his recall, and sent Málek el Ashter to supersede him. The latter, however, never reached Egypt, being poisoned while on his journey out, at the instigation of Moa"wíyeh.

Taking advantage of the confusion which these events had caused, Moa"wíyeh despatched 'Amer ibn el "As to wrest the government of Egypt from Mohammed, who still exercised authority in 'Alí's name. Mohammed was quickly routed and put to death by the victorious 'Amer, who seized the government, and continued to hold it until his death. 'Amer ibn el "As was succeeded by 'Abdallah, the son of Moa"wíyeh, who was, however, displaced by that caliph, to make room for his brother, Aiyineh ibn Abí Sufyián. Subsequent governors of the province were 'Atbat ibn "Amer al Jehení, Moa"wíyeh ibn Khadíj, Muslimeh ibn Mokhalled (who died in Egypt during the caliphate of Yezíd), Sa'íd ibn Yezíd,

and in the reign of Ibn Zoheir, ʿAbdarrahmán ibn Makhzúm al Coreishí.

ʿAlí was the last of the four caliphs, or legitimate successors of Mohammed. His son Abu Mohammed al Hasan nominally succeeded him, but voluntarily abdicated to avoid embroiling the empire any longer in civil wars and bloodshed. He was shortly after poisoned by Yezíd, the son of Moa"wíyeh, at his residence in Medina. The caliphate then devolved upon the Ommiades, fourteen of which dynasty reigned during a period extending over 88 years. These were:

1. Abu ʿAbdallah Moa"wíyeh ibn Abi Sufyán, A.D. 661—750, who had been governor of Syria, under ʿOmar, but was recalled by ʿAlí, against whom he subsequently revolted.
2. Yezíd, his son, A.D. 679—683. His accession was opposed by Husein, the son of ʿAlí, who, as the legitimate descendant of the Prophet's family, caused himself to be proclaimed caliph at Cúfah, but was treacherously murdered by the agents of Moa"wíyeh. In the murder of Husein and his brother Hasan, originated the two great factions of the Mohammedan sect, the Sunnís and Shiites, of whom, the former supported the pretensions of Moa"wíyeh, and the latter upheld the rights of the family of ʿAlí.
3. Moa"wíyeh II., son of Yezid, A.D. 683. Abdicated after a reign of six weeks.
4. Merwán ibn el Hakem, A.D. 683—684.
5. ʿAbd el Melek, son of Merwán, in Syria, and ʿAbdallah ibn Zobeir, reigning contemporaneously in the Hejáz, A.D. 684—693.

[The governors of Egypt during this period (A.D. 683—693) were: ʿAbd el ʿAzíz, son of Merwan, who died at Helwan, where he had constructed a Nilometer; ʿAbd el Melek (afterwards caliph); ʿAbdallah, deposed by his brother Walíd; these were succeeded by Siríy ibn Sharík, a most oppressive ruler; ʿAbd el Melek ibn Rafa"eh; Aiyúb el Asbahí; Bashar ibn Safwán el Kalbí; Hanzaleh, his brother; Mohammed ibn ʿAbd el Melek, brother of the Caliph Heshám; Hafs ibn Walíd; ʿAbd er Rahmán ibn Khalíd; Hanzaleh ibn Safwán (second time); Hassán ibn al ʿAtáhiyeh; Hafs ibn Walíd (second time); Jauthirah ibn Sahl el Báhilí; Mogheirah ibn ʿObeid el Fazárí; ʿObeid allah ibn Merwán, the last of the Ommiade family who ruled in Egypt.]

6. Walíd I., son of Abd el Melek, A.D. 705—715. Conquers Spain in A.D. 710.

7. Suleimán, A.D. 715—717. Conquered before Constantinople. He was the first who established a Nilometer in the island of Roda.
8. Omar II., A.D. 717—720. Son of 'Abd el 'Azíz.
9. Yezíd II., A.D. 720—724. Son of 'Abd el Melek.
10. Heshám, his brother, A.D. 724—743. Defeated in France by Charles Martel, 732.
11. Walíd II., A.D. 743—744. Son of Yezíd II.
12. Yezíd III., A.D. 744. Reigned only five months, and died of the plague.
13. Ibrahím, A.D. 744. Deposed by Merwán II. after a reign of three months.
14. Merwán II., A.D. 744—750. The Abbássides, or descendants of Abbás, the son of Abd el Motleb, uncle of the Prophet, revolted against this prince, and defeated him in a battle fought at a town called Abusír, near the Faiyúm, in Egypt, where he himself was slain.

The caliphate thus fell into the hands of the Abbássides, who held it until A.D. 1258. There were in all thirty-seven caliphs of this house, and a prophecy (not however destined to be fulfilled) declared that they should retain the supreme authority until the advent of el Mehdi, in the Mohammedan millenium.

1. Abu 'l Abbás Abdallah as Seffáh, the fourth in descent from Abbás, A.D. 750—754.
2. Abu Ja'fer Abdallah el Mansúr, A.D. 754—775. Founded Baghdád, which became the seat of empire under these caliphs.
3. El Mahdí, his son, A.D. 775—785.
4. El Hádí, his son, A.D. 785—786.
5. Hároun er Rashíd, A.D. 786—809. This was the celebrated hero of the "Arabian Nights," and the ally of Charlemagne.
6. Mohammed el Amín, his son, A.D. 809—813.
7. 'Abdallah el Mámún, son of Hároun er Rashíd, A.D. 813—833. He was a great patron of literature, and it is to his zeal in this cause that we owe the preservation of many of the Greek philosophic and scientific works which he caused to be translated into Arabic. He also introduced, from India, many arts and sciences hitherto unknown.
8. Al Mótassem billah, A.D. 833—841. Was the first to employ a Turkish body guard.
9. El Wathek billah, A.D. 841—847.
10. El Motawakkal 'al' Allah, A.D. 847—861. Graduated the new Nilometer at Roda.

11. El Mostanser billah, A.D. 861—862.
12. El Mustaín billah, A.D. 862—866.
13. El Mo'tazz billah, A.D. 866—869.
14. El Mohtadí billah, A.D. 869—870. Ahmed ibn Tulún revolts in Egypt, and establishes an independent kingdom there.
15. El Mótamed 'al' Allah, A.D. 870—892.
16. El Mótadhed billah, A.D. 892—902.
17. El Moktafí billah, A.D. 902—908.
18. El Moktader billah, A.D. 908—932.
19. El Káher billah, A.D. 932—934.
20. Er Rádhí billah, A.D. 934—940.
21. El Muttakí billah, A.D. 940—944.
22. El Mustakfí billah, A.D. 944—945.
23. El Motí' 'al' allah, A.D. 945—974.
24. El Tái' billah, A.D. 974—991.
25. Al Kadir billah, A.D. 991—1031. Peter the Hermit preaches the Crusade.
26. Al Káïm billah, A.D. 1031—1075.
27. Al Muktadhí billah, A.D. 1075—1094. Jerusalem taken, 1076.
28. El Mustazhir billah, A.D. 1094—1118.
29. El Mostarshed billah, A.D. 1118—1135.
30. Er Rashíd billah, A.D. 1135—1136.
31. El Moktafí billah, A.D. 1136—1160.
32. El Mostanjed billah, A.D. 1160—1170.
33. El Mostadhí billah, A.D. 1170—1180. Saláh eddín (Saladin), Sultan of Egypt, conquers Syria, Mesopotamia, and Arabia.
34. En Násir ledín ellah, A.D. 1180—1225. Fourth Crusade. Constantinople taken by the French and Venetians.
35. Ez Záher billah, A.D. 1225—1226.
36. El Mustanser billah, A.D. 1226—1240.
37. El Mosta'sem billah, A.D. 1240—1258.

With Mosta'sem ended the dynasty of the house Abbás. Their downfall was brought about by the treachery of Mosta'sem's vizier, Ibn el 'Alkama, who, being of heretical tendencies, cherished a rancorous hatred against the Sunní sect. The object of his intrigues was to strip the Abbassides of the caliphate, and restore it to the family of 'Alí. 'With this end in view he opened a correspondence with Halakú Khan, the celebrated Tartar chief, and excited his cupidity by relating to him the immense wealth of the treasury at Baghdad, and the weakness of the city defences. By way of still further diminishing the possibility of resistance, he prevailed upon the caliph to retrench his army estimates, and disband no less

than twenty thousand of his soldiery. The invasion of Irák by the Tartar hordes at last aroused the caliph, and he set about making what preparation lay in his power to resist the inroads of the barbarians. But his precautions came too late, and Baghdád speedily fell a victim to the combination of superior numbers and treachery which was brought against it. The caliph was defeated with immense loss, those of his men who had escaped the swords of their enemies perishing miserably in the waters of the Tigris. The town was sacked, the women and children taken captive, the treasury plundered, and the caliph himself thrown into a dungeon and loaded with chains, where, as soon as the conquerors were satisfied that he had no more hidden treasures to point out to them, he was barbarously put to death.

The traitor ʿAlkama met with the fate which his infamy deserved, for, no sooner had the Tartar chief made himself completely master of the capital, than he degraded the ex-vizier to the position of the lowest menial, and heaped upon him every indignity and torment until death put an end to his sufferings. The uncle of Mostaʿsem, after these events, fled to Egypt in the time of the Sultán Beybers, and the Beni Abbas continued to exercise the caliphate in that country, but only as a spiritual authority, until A.D. 1577.

During the continuance of the Abbasside dynasty, fifty-seven of their lieutenants had governed Egypt. Amongst these was Ahmed ibn Tulún (or Taylún), who was viceroy under the Caliph El Moʿtazz billah, A.D. 868. This prince rebelled against his master, defeated him in a pitched battle, and assumed the rank and title of Sultán, or independent sovereign of Egypt. He built the celebrated mosque at Cairo which bears his name at the back of the Cattáʿ, or Calaʿt el Kebsh, in the eleventh year of his reign (A.D. 879). He was a great patron of literature, and increased considerably the power and resources of the country. His liberality was proverbial, and it is said that he was in the habit of distributing no less than one thousand dinars daily in alms to the poor. He died A.D. 884, after a prosperous reign of twenty years, and was succeeded by his son, Abu 'l Jaish Kháraweeyeh; he was murdered by one of his concubines at Damascus, and his body removed to Egypt for burial, A.D. 896. His daughter, Catr en nedá, married the Caliph Moʿtadhed. His two sons, Abu 'l Asáker and Abu Musá Harún, successively ascended the throne of Egypt, but were killed soon after their accession, the first in A.D. 896, the second in the following year.

Abu 'l Maghází Shíbán, son of Ahmed ebn Tulún, then assumed the reins of government, but he had not reigned twelve days when

a revolt broke out among the generals of the late sultan, Abu Musá Harún. Led by Mohammed ibn Suleimán, a slave of Ahmed ibn Tulún, they deposed Shibán, burnt the palace of el Catái', pillaged Fustát, and expelled the remainder of ebn Tulún's family from the country, after they had reigned in all thirty-seven years. The government of Egypt then became again vested in the house of Abbás, in the caliphate of Al Muktafí, and their lieutenants continued to rule as formerly. One of these governors, Mohammed ibn Tafaj al Akshíd, a Turk by descent, assumed the position of an independent prince, and caused himself to be proclaimed king, A.D. 936.

He was followed by his son, Abul Cásim, who, however, delegated all authority to a black slave named Kafúr, and died in A.D. 948. Abu 'l Hasan Alí, a son of Akshíd, then reigned for two years, the real authority still continuing in the hands of Kafúr until the latter actually assumed the office and title of sultán, and reigned with great ability over Egypt, Syria, and Hejáz. He died in A.D. 969, and was succeeded by Ahmed ibn 'Alí al Akshídí. The latter was, however, deposed in the following year by Jauhar, the general of Abu Temím, as will be presently detailed. With him ended the Akshídí dynasty, after a rule of nearly thirty-five years.

WOMANKIND:

IN ALL AGES OF WESTERN EUROPE.

BY THOMAS WRIGHT, F.S.A.

(With a Coloured Plate.)

CHAPTER XVIII.

COSTUME IN FRANCE IN THE SIXTEENTH AND BEGINNING OF THE SEVENTEENTH CENTURIES.

As we have seen, the costume of the ladies of the close of the fifteenth century, and of the earlier years of the sixteenth, was far from inelegant, and presented little of the extravagance which marked it in the latter half of the same century. The pride of dress appears at this time to have been spreading widely among the bourgeoisie; and this not only formed the excuse for the multiplication of sumptuary laws, but it provoked the frequent attacks of the satirical writers of the day. Some of these furnish us with curious sketches of contemporary dress and manners. Thus, towards the beginning of the century, when, during the Italian wars, the court of France was for several years established at Lyons, and a sort of rivalry arose between that city and Paris, there appeared a short piece in verse, purporting to be an attempt by the women of Lyons to reform those of the capital, who were especially charged with pride and extravagance. We learn from this that the women still continued to paint—

Vous vous fardez pour avoir plus beau taint.

The women at that time wore low shoes, held on by a band over the instep. They are accused of imitating the Italian women in everything, of adopting strange fashions, and of indulging largely in pride and vanity, till they became by their extravagance the ruin of their husbands.

—Pour vostre gravité
On vous nomme de Paris les poupées,
Painctes, fardées, de Grace mancipées:
Enveloppées de Folle Vanité.

The dames de Paris—for now the Parisians had taken possession of the title of dame—are made to reply in terms equally severe and sarcastic.* Another poem of about the same date bears the title of

* These pieces are printed by M. de Montaiglon, in his "Anciennes Poésies Françaises," tom. viii., pp. 244, 253.

an attempt to correct the superfluity of dress among the Parisian dames, and to teach them honest government (*sur le faict de la reformation de la superfluité des habitz des dames de Paris, et comment elles se doivent honnestement gouverner*).* In this very curious production the good lady of Paris is warned against wearing a collar or necklace of gold,—

Premierement ne porteres
Carcans dorez ne jazerans.

She was advised to cut off the tail of her robe, and not turn it up to show, as an article of pride, the rich lining underneath. She is warned especially against perfumes of all kinds, though she may use on occasion lavender or souchet (the *cyperus longus* of Linnæus). Lavender had now taken the place of the older perfume of the feudal age, saffron, and appears to have become the favourite perfume.

Tout le parfum contemneras,
Car il est par trop acoinctant;
Et neantmoins sentir pourras
Lavande et souchet, dont est tant.

One or two other aromatics are alluded to. The city lady was to abhor the vertugal, and she was only to wear slit robes in two cases—first, when she was folding her washed linen; and secondly, when she was killing her pigs, two or three days before Advent.

Le premier est quand tu plieras
Ta lessive, et puis le suyvant
Sera quand tes pourceaulx tueras
Deux ou trois jours devant l'Advent.

She was to ride on the croop of the horse behind her husband; and, when she visited the farm, she was to sit on the shaft of the waggon, beside the waggoner, with her chambermaid behind her; but she was to keep her eye upon him, to prevent his making love to the maid. In the course of this little poem, we have a tolerably minute description of the dress of the Parisian dames of this period. Another piece, printed by M. de Montaiglon, and directed against the wives of the bourgeoisie, bears the title of *Les Presomptions des Femmes*. From it we learn that a simple burgher's wife would wear "rubies, and diamonds, and jewels."

Une simple bourgeoise aura
Rubis, diamants, et joyaux.

The position of literature had been considerably changed by the introduction of printing, and popular satire was no longer

* Ibid, p. 290.

published in the baronial hall, but it was spread among the middle classes of society; and it was naturally aimed at the class which was to read it. Moreover we have, at the period to which these satires refer, fewer pictures to furnish us with examples than at the periods which either preceded or followed it.

FRENCH NOBLES, EARLY IN THE SIXTEENTH CENTURY.

Our cut represents a group of nobles, and is taken from the painted glass in the windows of the church of Notre Dame de Brou, in France, which was executed in the earlier part of the sixteenth century. The dress of the lady is much more simple than we have been accustomed to see it in the fifteenth century. The next cut is taken from a picture by Jost Ammon, and is understood to represent two French ladies of the same century, but somewhat later. It will be seen at once that the whole character of the costume is changed.

Among the higher classes, and among those who aped gentility, the Italian fashions chiefly influenced the dress of both sexes, which still was far from wanting in elegance. The waist was fitted close to the body in front, so as to give the form of the bust. The sleeves were fitted tight at the wrist, and the jupe was wide and

LADIES OF THE SIXTEENTH CENTURY.

flowing. After the arrival in France of Catharine de Medicis, the most extravagant exaggerations were introduced into every part of the dress. The vertugalle—or, as we called it in England, the fardingale—appears to have been derived originally from Spain, under the name of the vasquine, or basquine. People compared the general shape of this dress, with some justice, to that of an hour-glass, or of two bells joined together at the extremities. The

sleeves were formed of rolls, very large at the shoulder, and diminishing as they descended to the wrist, so as to present an object anything but graceful. The head emerges from a vast ruff, or frill, supported by wires, which gave it the form of a fan. In the reign of Henri IV., it was made to rise behind, more than a foot above the head. People of rank only were allowed to wear trains or tails to their dresses, but these were extravagantly long, according to the degree of nobility of the wearer. It was usually from five to seven yards long, and of course a maid or a page followed the wearer to lift it up. The tail of the robe of Queen Elizabeth of Austria, when she entered Paris in 1574, was twenty yards long, and was, in fact, the longest example known. It has been remarked that all the ridiculous fashions which have been witnessed from the seventeenth century to the present day are found under other names in the costume of the ladies of the sixteenth century.

Our next cut is taken from a portrait in the Library of St.

MADAME DE SAUVE.

Geneviève, in Paris. The lady it represents was the daughter of Jacques de Beaune, Baron de Semblançay, and was placed, when very young, in the household of Catharine de Medicis. This

daughter of the Baron de Semblançay yielded herself readily to all the intrigues of the licentious court of that queen; but this, in those days, in France, was no hindrance to marriage, and, about the year 1570, she married Simon, Baron de Sauve, who had been made Secretary of State in 1567. Her married life was no better than that which had preceded it, for she openly gave her husband, for rivals, all the lords of the court who pleased her, and her con-

A LADY IN FULL DRESS.

duct was considered excusable, and brought her no discredit. Such was Womankind at the court of France in the sixteenth century. Her first husband died in 1617, and she married another, with whom she was less faithful than ever. Madame de Sauve was a woman of celebrity in her time. Her portrait gives us a good example of one form of the ruff, as well as of the head-dress.

CHRISTINE DE PISAN PRESENTING HER WORKS TO THE QUEEN.

During this period, the variety of women's coiffures was very great, and they were generally elegant. Sometimes they raised the hair above the head in a sort of pyramid. At others, they smoothed the hair down in flat bands on the forehead, and collected the locks in a tuft behind, or let it fall loose on the shoulders. Sometimes they curled it. Towards the end of the sixteenth century, hair-powder came into common use. Pierre de l'Etoile speaks in his Journal of seeing nuns walking about the streets of Paris with their hair curled and powdered.

Our cut represents a lady of the time of Henri IV. Her dress, which is black upon a white petticoat, with its sleeves, represent the general forms of that time. She has earrings and necklace of gold, and her hair is bound by a band of pearls.

The fan was looked upon as indispensable, and was often made of rich materials, and highly ornamented. The form of fan seen in our picture belongs to the earlier part of the seventeenth century, and was derived from Italy. The fan of the sixteenth century was of a round form, usually made of feathers, and had often rather a long handle. The fan given by the queen of Navarre to Marguerite of Lorraine, the queen of Henri III., was made of mother-of-pearl, covered with rich gems, and was valued at twelve hundred écus of gold. Masks were greatly in vogue during the whole of this period, but especially during the reign of Henri III., arising, no doubt, out of the general licence of manners. They were commonly called *loups*. They were generally made of black velvet, lined in the inside with white satin. In the inside was a little chain, which, when the lady had the fan upon her face, she held tight between her lips, to keep it in its place and prevent its falling.

I have said that the practice of painting was still in general use. In the seventeenth century a new fashion came in, of ornamenting the face with spots or patches, which were considered to add so much to the beauty of those who wore them, and to make such a decided impression on the hearts of the other sex, that they gave them the name of "assassins." The readers of La Fontaine's Fables will remember how he makes the fly say:—

> Je rehausse d'un teint la blancheur naturelle;
> Et la dernière main que met à sa beauté
> Une femme allant en conquête,
> C'est un ajustement des mouches emprunté.

The general costume of the ladies under Louis XIII. differed little from that of the previous reign, but under Louis XIV. it was

entirely changed. The vertugalle, the stiff formal body, the ruff, the puff sleeves, had all disappeared, and the dress altogether became freer and more easy. The shoulders and breast were left

A LADY OF FASHION.

uncovered, and the great outcry of the moralists was now against what they called the indecent exposure of the person. Our last cut represents a lady of this period, which will best exhibit the change. Her dress, as will be seen, is covered with ornament. She has a necklace of pearls round her neck; a double row of large pearls are suspended over her bosom; and she has a band of pearls over the head.

The coloured plate given with the present chapter illustrates one of the interesting phases in the history of Womankind in France. Through the Middle Ages, the women of France had, on various occasions, distinguished themselves in the paths of literature; but their literary talents appear to have been brought especially into activity at the close of the mediæval period. Among the most remarkable of the French literary ladies was Christine de Pisan, a lady of Italian origin, as her name indicates. She began her literary career as a poetess, but she afterwards embraced a wider

field, and, writing with equal facility and vigour in prose and verse, she took an active part in all the great questions, political and social, which agitated the earlier part of the fifteenth century. Among the manuscripts in the British Museum (MS. Harl., No. 4431), there is a large, handsome volume, written on vellum, and richly illuminated, containing the works of Christine de Pisan. It is one of these illuminations that we have copied in our plate. It represents Christine presenting her book to Isabelle of Bavaria, the queen of Charles VI., and may be assumed to be intended as portraits of the poetess and of the queen. It is, moreover, an excellent illustration of the costume of that period. The manuscript was written in the year 1404, when Christine was thirty-nine years of age.

MORAL VALUE OF NATURAL HISTORY.

Miss Burdett Coutts has recently called attention to the importance of inculcating benevolence to animals as part of the education of young people. English boys are said to be more cruel to animals than the boys of France or Germany, or, indeed, of any other European country; but it might be affirmed, with at least equal truth, that they are greatly addicted to keeping animal pets. Almost all boys are fond of dogs, though nearly all persecute cats; the majority like to keep rabbits, guinea pigs, white mice, dormice, etc., which they tend with care and attention, and yet the very same individuals will rob birds' nests, destroy their callow brood, pin cockchafers, pelt frogs, and torture newts. There are exceptional boys who delight in cruelty, and they frequently grow up with their evil propensities strengthened by age and exercise. There are also men of brutal disposition who have acquired their ruffianism after passing through the juvenile stages of their existence, and they are at once the plagues and the puzzles of society, defying its punishments and resisting its benevolent endeavours.

Cruelty to animals is partly the work of brutal natures, and partly perpetrated by well-meaning people under the influence of bad habits, in relation to the particular creatures they torment; and if we could estimate the total quantity of cruel infliction imposed upon birds, beasts, reptiles, and fish, we should probably find that by far the larger proportion resulted from the ill-regulated action of

good, and even benevolent persons. Much illtreatment of animals comes out of the ordinary proceedings of trade. It has been the custom to bleed calves, to cram sheep and poultry into the smallest possible apparatus of transport, to drive cattle for long distances without permitting them to drink, and to slaughter them without sufficient avoidance of pain. Each little circle in which these malpractices occur, forms its own theory of cruelty and benevolence, and laughs scornfully at outsiders who object to its ways. The fox-hunter thinks a man a fool who reminds him of the unbenevolent character of his sport, and the fine ladies who flock to aristocratic pigeon matches, have no more compunction at witnessing the sufferings of the maimed birds, than the Spaniards have for the gored horses and tortured bulls in their disgusting national recreation. It may be affirmed as a general proposition, that the cruelty of custom or indifference does not lead to the demoralization which inevitably results from a deliberate choice of action that inflicts unnecessary pain, and yet all familiarity with needless and useless suffering must tend to damage character, unless it excites strenuous resistance to the evil, and efforts for its cure.

The circumstances that combine to form brutal characters in modern society are extremely complicated, and lie for the most part outside the matters we have now to discuss. Our object is to show that ignorance of the character and ways of animals, is one of the chief preventible causes of the cruelty that is inflicted upon them, and that the method of cure is by teaching natural history with due reference to its moral aspects. Many ill-used creatures are the subjects of an aversion which would be changed to liking, or at any rate to respect, if their nature and actions were better understood; while many others suffer under simple indifference because they have not been brought within range of sympathy. Mr. Lecky tells us that Sir Robert Peel was opposed to the abolition of bull-baiting, and Professor Huxley recently uttered some unworthy nonsense against the act for preventing the wanton destruction of the sea birds on our coasts. For a long time game cocks were excluded from humane sympathies, and many a country gentleman and clergyman who would have been roused to indignation at cruelty to a horse, thought it a great shame when Parliament provided penalties to put down the fights which were elaborately arranged between the pugnacious birds.

In one instance known to the writer, the manager of a large colliery, who was determined to civilize his men, was privately urged by rural justices not to bring cases of cock-fighting before them,

as they could not find it in their hearts to punish others for an action they still delighted to commit in secret themselves.

In the "good old times" cruelty was incidentally, but not less powerfully taught in our chief schools. The masters inflicted upon their pupils brutal floggings, the big boys grossly tyrannized over the little ones as fags, and each member of the society, receiving maltreatment from those stronger than himself, handed it over to others, over whom he could play the despot in turn. The public amusements, until recent periods, included bear and bull-baiting, cock-shying, dog-fighting, cock-fighting, and man-fighting, while duelling was the fashionable method of adjusting disputes. During the same dark days, hatred of foreigners was inculcated as a national duty, and no human rights were supposed to belong to men who were born with black skins. Class hatreds matched international animosities, the upper circles made laws against those beneath them, which were correctly described as written in characters of blood, and if circumstances gave the lower classes opportunities of revenge, they did not fail to show how successfully tiger's qualities had been cultivated in their breasts. We have been slowly learning that all human beings are entitled to just and equitable treatment, and we have included one group of animals after another in our system of legal protection, so that the chief work which remains to be done is to widen our sympathies until no living thing shall be improperly excluded.

We do not want a mawkish sentimentality about the sufferings of animals, or men. Individuals afflicted with this form of mental disorder can weep hysterically over a damaged blue-bottle, and behave abominably to their relations and friends. Fantastical horror of pain is by no means incompatible with gross cruelty in its needless infliction, and we should not put implicit faith in the benevolence of individuals who voluntarily allowed fleas to dine off their juices, or assuaged the hunger of tigers with their blood. Animality-mongering is no better than humanity-mongering, but a wholesome fellow feeling for our "poor relations" in the organic world below us is a graceful attribute of a well-developed mind.

Natural history, as a mere science of arrangement, has little moral influence until it reaches its final stages, and by exhibiting all living beings as one great organic unity, sheds some portion of the dignity and worth of the highest upon the lowest forms; but when it is made to include habits and manners as well as structural peculiarities, its influence in extending the range of sympathies is very direct. Rude or prejudiced thinkers do not see how doctrines

of unity tend to this result. The semi-civilized white man felt, and still feels, his sham dignity hurt by pointing out that he belongs to the same species as the negro he maltreats, and the Darwinian theory has met with rampant abuse as lowering humanity by suggesting its origination from lower forms of being. But were it proved that man's ultimate great grandmother was an infusorial speck, and that all the mammalia were cousins, so many degrees removed, the man would be no less, though the mammals might seem so much more, and if such theories of development are entirely discarded, we may still be benefited and more kindly disposed, if we learn and honestly recognize the fact, that animals have, within narrower limits, moral and intellectual faculties of the same nature as our own.

A wise teaching of natural history brings this lesson into strong relief, and no one can be an observer of tame creatures without finding out that they have their feelings of pride, justice, and even duty, very similar to our own, and that the difference is not one of essential nature, but of development, and method of combination. The more we know of the proceedings of animals the less we ascribe to a blind instinct, and the more we discover that within the limits of their faculties they exercise discrimination, and modify their conduct to suit new circumstances or enable them to take advantage of new ideas. This last expression will doubtless excite a smile; but our readers will recollect what Mr. Wallace told them about the birds of wild countries, and the readiness with which they learnt what to do with articles their predecessors had never seen, and with buildings the like of which had had no existence in their progenitor's days. The first bird who saw that a fragment of clothing might be worked into his nest, and acted upon it, and the first which made his dwelling in a tower, or under the eaves of a house, were discoverers and inventors quite as truly as are men who find out the use of new things.

Natural history can easily be worked into the routine of school teaching; but it ought also to take its place among the recreations of family life, and in that position it will be most effective in promoting a good moral end. As instruments of intellectual discipline, all sciences which include logical classifications have an obvious value, and when even elementary natural history is associated with comparative anatomy and physiology, it supplies an excellent training for the mind.

The study of animals in reference to their structure is capable of being made a fascinating pursuit, especially if the modern dis-

coveries concerning the unity of plan in creation are fairly considered, and care is taken not to give undue prominence to imperfect conceptions of the supposed purpose and object for which the structure was designed. An unphilosophical natural history treats each creation as a separate unit, and fails to show its true relation to either living beings or to fossil forms. With a vain presumption of "knowing all about it," it finds the sole cause of any structure in the function it performs, and thus misses entirely the larger views which science can unfold. The most interesting generalizations reached through the labours of such men as St. Hilaire, Goethe, Oken, Van Baer, Herbert Spencer, Huxley, Darwin, etc., can be made intelligible to those who possess only a popular knowledge of anatomy and physiology, provided it be sound as far as it goes; and the student of natural history, even for recreational purposes, should not be satisfied without obtaining some insight into this part of the science.

When we urge upon teachers the propriety or utility of adding one subject after another to school-training, we must remember, not only that "art is long," but that school-time for the mass of the people is very short. The school ought certainly not to omit natural history, but its chief cultivation must take place independent of school aid, and after its termination. The school may lay a foundation, but it is after school-time that the structure must be raised, and if a capacity for, and a habit of, making intelligent observation can be cultivated in youth, few will be without opportunities for their exercise in the years of manhood and age.

GAUGING THE NOVEMBER METEOR-STREAM.

BY R. A. PROCTOR, B.A., F.R.A.S.,

Author of "Saturn and its System," etc., etc.

LAST year I discussed the figure of the November meteor-orbit, showing how we learn from the researches of Professor Adams that the meteoric-system extends far out in space beyond the orbit of Uranus. This year I wish to deal with another and equally interesting feature of the November meteor-system, namely, the varying depth of the stream of cosmical bodies of which it consists. We have been fortunate enough to obtain accounts of the display during three years in succession, and these accounts are of such a nature that we can determine the hours at which the display has commenced and terminated *for the whole earth*, as distinguished from the apparent commencement or termination at particular places. And the information thus secured serves to add considerably, not only to the interest with which we regard the whole subject of the November meteors, but to that with which we look forward to the display of the present year. It is important that observers should be aware of the fact that this year's display, if it should be well observed, will serve to confirm or to disprove certain remarkable conclusions which have been drawn from the observations made last year.

Let us briefly consider what we have hitherto learned respecting the depth of the meteoric system at those particular parts of its length at which the earth has traversed it during the last few years; and, then, by combining together the information thus obtained, let us endeavour to form a conception of the *shape* of the meteor-stream.

In November, 1867 (see "Intellectual Observer" for that month), I examined, at considerable length, the evidence we had obtained respecting the part of the system traversed by the earth in 1866. Since that paper was written I have obtained evidence on a point then referred to as doubtful. I have learned that in India the display began some hours before four A.M., local time. Therefore the thickness of about 100,000 miles, which I then assigned to the meteor-system at that part of its course, may be increased to some 110,000 or 115,000 miles.

In November, 1868, I dealt with the Earth's passage of the meteor-system in 1867. The evidence from America served to

prove that a very fine display had been observed; but that the display did not last so long as in 1866. And the conclusion to which we were led was that the thickness of the meteor-stream, where the earth then traversed it, was little more than 60,000 miles.

Thus we seemed to have evidence of a thinning off of the meteor-system. And remembering that the comet, with which the system seems in some inexplicable way to be associated, had crossed the earth's orbit shortly before the display of November, 1866, we might not unreasonably have been led to the conclusion that the thickness of the meteor-system diminished in proportion to increased distance from the cometic nucleus. This inference would have led us to expect in 1868 a display of a very unimportant character, and visible over a very limited area. The particular region over which the display was to be looked for was not a promising one. "In fact," I wrote at the time (and, in a letter sent soon after to "The Times," Mr. Hind, the superintendent of the "Nautical Almanac," expressed a very similar view), "it is not likely that the display will be well seen by practised observers anywhere. In New Zealand it may be seen, though the position of New Zealand on the earth's southern hemisphere is unfavourable. It is possible that a few travellers, who may happen to see the phenomenon from various parts of the Pacific in which the display may be visible, will think it worth their while to report their observations. On the whole, however, it is more than probable, that we shall hear nothing of the November shooting-stars of the year 1868."

Therefore, when news was received from various parts of England that the display had been well seen, the explanation to which astronomers somewhat hastily jumped was on this wise:—The November meteors traversing their wide orbit around the sun, are liable to be attracted from their normal paths by the influence of Jupiter, Saturn, and Uranus—all three being giant members of the planetary system—and as all the meteors travelling in a given part of the system must be subject to the same influence, it is clear that the meteor-stream will be liable to changes of figure, resembling the vibrations which pass round an elastic hoop that has been sharply struck. And though these vibrations, considered with reference to the whole orbit of the meteors, might appear as insignificant as the scarcely perceptible vibrations of our illustrative hoop, yet they must shift the meteor-stream through spaces of enormous real extent. So that if the earth reached in November a part of

the system where the range of vibration from the true orbit was a maximum, the epoch of the display might be hastened or delayed by several hours. And thus the unexpected occurrence of a display in November, 1868, might fairly be accounted for.

Although this reasoning is undoubtedly plausible—nay more, though it is undoubtedly true that the meteor-system must be subject to vibrations of the kind considered, yet it very soon appeared that the occurrence of a display in November, 1868, was due to a cause of quite a different character.

Remembering the evidence obtained in 1867, of a thinning off in the meteor-stream, it will be evident that, supposing the part passed through in 1868 to be correspondingly diminished in thickness, the display could not have lasted more than two or three hours; and therefore, being, as I have said, well seen in England, it would necessarily have been invisible (occurring in the daytime) in America.

But news was received that the display had been well seen in the United States.

It was at once evident, therefore, that the process of thinning off had been followed by a contrary process, and that in fact the thickness of the stream where the earth crossed it in 1868, was not only greater than at the part traversed in 1867, but even than at the part traversed during the great display of 1866.

This result is so interesting, and serves so largely to enhance the interest with which we look forward to the display of the present year, that it may be well to consider somewhat closely the evidence on which it rests.

So far as the display in England is concerned, we have very satisfactory evidence. Let us take Professor Grant's description of the shower as observed at Glasgow.

Until about half-past two on the morning of November 14th, the sky was somewhat overcast, but it was evident even then, that a shower was in progress, as a meteor would be seen every now and then to flash across an opening between the clouds. At half-past four it was clear in all directions, and it became easy for the observers to convince themselves that the meteors which appeared in every part of the heavens belonged to the November system. In every instance the course of the meteors was found to emanate from the radiant of the November system. The meteors were commonly white, but in some instances a trace of red could be recognised. It was noteworthy, however, that no trace was visible "of the beautiful green which formed so interesting a feature of many of the meteors

of November, 1866." This peculiarity is well worth dwelling on for a moment. It would be an interesting circumstance if we could trace a systematic law of change in the character of the meteors, according with their distance from the cometic nucleus of the meteor-system.

Many of the meteors were large, "three or four exceeding Jupiter in brightness, but not equalling the planet Venus, which was shining with intense brilliancy in the east, and formed an excellent standard of comparison for estimating the brightness of the larger meteors." Size again—that is (1) the average size of the meteors, and (2) the size of the largest which make their appearance—is a feature which should be carefully attended to in observing the coming display. We want all the evidence we can get to guide us towards a solution of the difficult questions suggested by the meteors; and we must not be deterred by considerations of the apparent insignificance of this or that feature, from recording every phenomenon which may by any possibility afford a useful hint.

But our chief concern at present is with the thickness and density of the meteor-stream.

Professor Grant and his assistant noticed that the shower sensibly increased, from 4h. 30m. to 4h. 56m., and "as it appeared very desirable to endeavour to ascertain the time of its maximum," he "proceeded, in conjunction with Mr. John McKinnel, the junior assistant, to count the number of meteors which might become subsequently visible." It would appear from the resulting numbers that the shower attained its maximum at about a quarter past five. But there was no such sharp accession of richness as had been observed in 1866 or even in 1867. The following table, which indicates the number of meteors seen in successive intervals of five minutes, commencing at four minutes before seven, serves to prove this:—

	h.	m.		h.	m.		Meteors.		h.	m.		h.	m.		Meteors.
From	4	56	to	5	1	.....	22	From	5	31	to	5	36	.....	16
	5	1		5	6	.....	28		5	36		5	41	.....	12
	5	6		5	11	.....	27		5	41		5	46	.....	14
	5	11		5	16	.....	27		5	46		5	51	.....	11
	5	16		5	21	.....	16		5	51		5	56	.....	13
	5	21		5	26	.....	20		5	56		6	1	.....	8
	5	26		5	31	.....	21		6	1		6	6	.....	19

We shall presently see that Professor Grant observed neither the real beginning nor the real end of the display.

We turn next to the observations made in the United States. Professor Kirkwood records them, but was unfortunately unable to take part in them as on former occasions. *On the morning of the* 13th, Professor Wylie observed 165 meteors, of which the greater number belonged to the November system. *After sun-rise,* Professor Kirkwood bethought him of an observation made by Humboldt in 1799, and "standing in the shade, on the western side of a building, watched the vicinity of the radiant, hoping to see some of the largest of the meteors." He saw five or six, and Mr. Maxwell, a tutor in the State University, who watched with him afterwards, "saw *one,* beyond doubt, and three others less certainly." This fact is interesting, as confirming Humboldt's assertion that the meteors can be seen in the daytime.

On the night of the 13th the display was well seen. A committee of the senior class in the University kept watch from 11 o'clock P.M. till 4h. 15m. A.M. (Cincinnati time), during which they counted no less than two thousand five hundred meteors. The maximum was at about half-past three, "nine hundred meteors, having been counted during the forty-five minutes immediately preceding." This is at the rate of one hundred in five minutes, and enormously exceeds the numbers counted in corresponding intervals by Professor Grant and his assistants. Many of the meteors were very brilliant, and left long trains which continued visible for several minutes. Three or four were observed to explode, or at least to separate into several parts,—a phenomenon which had not before, so far as I know, been observed, in connection with the November meteors.

At five minutes to five the watch was renewed by Professor Wylie, who continued to observe the meteors until 6h. 11m., counting seven hundred and eighty in one hour and sixteen minutes.

There are several remarkable points to be noticed in this narrative:—

In the first place, the display began on the night of the 12th, and was still in progress at daybreak on the 14th, or more than thirty hours later. In 1866 the display did not last more than five or six hours, and in 1867 its duration was even less.

Again, the epoch of maximum display observed in the United States, does not by any means correspond with the hour named by Professor Grant. The difference of time between Cincinnati and Greenwich is about 5h. 38m., so that the hour of Professor Grant's maximum (5h. 15m., on the morning of November 14th) corresponded to twenty-three minutes before midnight, November 13—14

at Cincinnati. Hence, nearly four hours after Professor Grant's maximum, the earth passed through another and a much denser part of the meteor-system.

Again, a fact was noticed in America which serves to confirm the evidence which the circumstance just noticed affords, of a stratification of the meteoric-system, in that region which the earth traversed in 1868. At frequent intervals throughout the night, says Professor Kirkwood, "a lull occurred in the display; while at other times, for a few seconds, the meteors were so numerous, that they could scarcely be counted."

But the meteors were to be seen at yet a third station, far removed both from England and from the United States, and it will be well, before summing up the evidence which last year brought us, respecting the constitution of the meteor-system, to examine the facts observed at this third station, the Cape Town Observatory.

Mr. Maclear noticed the first meteor from the radiant in Leo, at 1h. 18m., Cape time. Such an observation, if made in England, would signify that the true commencement of the display had then taken place, and so would be discordant with the evidence from America. But a reference to the drawings of the earth which accompany my paper in the "Intellectual Observer" for November, 1867, will at once show that the Cape only began at about that hour to be within the range of the hail of meteoric projectiles. To represent the matter in another light, the radiant in Leo rises several hours later at Cape Town than in our latitudes.

The display was not very remarkable at first, nor indeed did it at any time attain such proportions as in the United States. Still at about a quarter to three, a shower of some importance seems to have been in progress, a dense haze concealing many of the smaller ones from view. The exact time which Mr. Maclear assigns as the epoch of maximum display is 2h. 42m., Cape time. This corresponds to about 1h. 31m., Greenwich time. Here then is another maximum, occurring before Professor Grant's—in fact before the sky had cleared at Glasgow.

But it is quite clear from Mr. Maclear's account that the true maximum did not occur at the hour he names. There were, in fact, several maxima. Certainly in the minute between 2h. 42m. and 2h. 43m., more meteors were seen than in any other single minute. But if we take the interval of ten minutes beginning at 2h. 37m., we find that only thirteen meteors made their appearance; whereas in the interval of ten minutes beginning at 3h. 37m., eighteen meteors were seen.

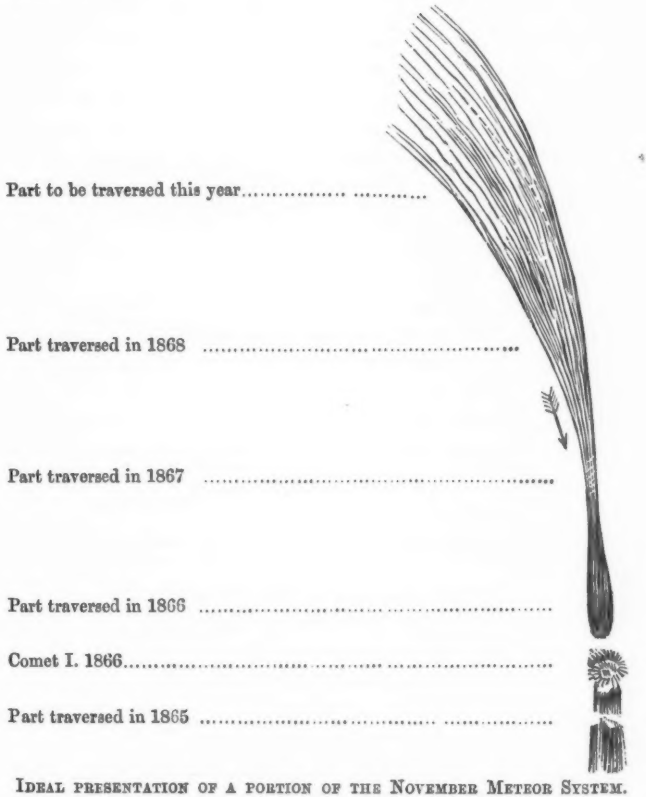
The fact is, Mr. Maclear's observations confirm those already recorded with respect to the evidence they afford of a very decided stratification in the meteoric-stream. At least that is the view which seems forced on us when we interpret what was observed last year, by means of what took place in the two former years. For in 1866 and 1867 there was so close an accordance between the epochs of maximum display observed in places very far apart, as to prove that the denser regions of the system were of considerable width—or in other words that there were real strata of meteoric aggregation. In 1868, we had no evidence of this sort, though we have none disproving the notion that the part of the system then traversed was also stratified. It is still possible, however, that the earth passed in 1868 through a succession of clustering aggregations rather than through strata of aggregation. Let us hope that the observations which may be made this year will serve to clear up this difficulty.

Let us now sum up the evidence we have respecting the portion of the system traversed in 1868; and then, comparing that evidence with what we know of the regions traversed in 1866 and 1867, let us endeavour to picture to ourselves the solid figure of the arc of the meteor-system extending from the place of Comet I, 1866, to the region traversed in 1868. We may add the observations made in 1865, though these applied to a part of the meteor-system which is travelling in front of the comet.

The earth occupied at least thirty hours in traversing the meteor-stream. As the passage was oblique we must not take the earth's orbital velocity of some sixty-five thousand miles per hour; but we must reduce our estimate to about eighteen thousand miles per hour, that being about the value of that portion of the earth's velocity which is carrying her *directly* through the meteor-stream. This gives to the stream a depth of no less than five hundred and forty thousand miles. So that the part traversed by the earth in 1868 was more than five times as deep as the part traversed in 1866, and nearly ten times as deep as the part traversed in 1867.

These results, combined with what is already known of the figure of the meteoric orbit, enable us to form some conception of the real figure of the meteor-system in space. It must of course be remembered that as the meteors circle round in their orbit, the condensation occupying successively different parts of the long oval figured in the "STUDENT" for last November, the configuration of the system must vary very strikingly. For example, when the condensed part of the system is near aphelion the whole of the richer

part of the system around the condensation must be compressed along a much shorter arc. We may measure this richer portion (in arc-length) by estimating the time which the last straggler belonging to it would take in reaching the position occupied by the leading member of the vanguard; and this time we may assume to be very nearly constant. This being so, it will be obvious from a moment's study of the orbit, in the number of the "STUDENT" just referred to, that when in aphelion the whole of the richer portion of the system may scarcely occupy one-tenth part of the space which the same portion comes to occupy when its condensation is travelling past perihelion.


Part to be traversed this year
Part traversed in 1868
Part traversed in 1867
Part traversed in 1866
Comet I. 1866
Part traversed in 1865

IDEAL PRESENTATION OF A PORTION OF THE NOVEMBER METEOR SYSTEM.
The cross section exaggerated many thousand fold.

It is only, therefore, at a special time that the accompanying drawing can be taken as illustrating the configuration of the part

of the meteoric-system which has during the last few years passed the descending node near the earth's orbit; at the present time, in fact, the meteor-system may be supposed to occupy such a position as is here depicted. It will be noticed that the cross section has been made to vary according to the gaugings obtained above. But it will be understood that it is absolutely impossible to indicate in a satisfactory manner the true relations of the system; because the cross section, if laid down according to the real dimensions of the system, would be almost evanescent unless the orbit were represented on a very large scale indeed. The figure, therefore, must be accepted as rather intended to indicate that the depth of the system varies according to such and such a law, than to present a true picture of the meteoric-system.

The comet (whose dimensions are enormously exaggerated) occupies the position indicated by the observations of 1866. No attempt has been made to indicate the connection between the comet and the meteor-system; because we are altogether ignorant what that connection may be. At present, indeed, there are few circumstances more perplexing than the observed association between comets and meteor-systems. That in several instances a meteoric ring should occupy the exact position of a cometic orbit can hardly be supposed to be merely an accidental coincidence. Therefore, some sort of association is indicated; but what the nature of the association may be, by which flights of solid bodies are connected with gaseous comets, is a riddle whose solution no information we at present possess enables us even to guess at.

One circumstance which has not hitherto, so far as I know, been considered (though it is so intimately associated with the inquiries of Hoek and others, that I am prepared to find I have been anticipated in dealing with it) seems to bear importantly on the relation in question.

It is well known that nearly all the comets which travel in periodic orbits around the sun, have been brought into their present subordination to the solar attraction, by the influence of the giant planets which travel outside the orbit of the asteroids. Each of these planets probably has its own family of comets, though hitherto we have only been able to satisfy ourselves respecting the existence of such a family in the case of the planet Jupiter. We know that a large number of comets have their aphelia close to the orbit of Jupiter, and we recognise the meaning of this when we remember that a comet travelling from outer space along a course which would bring it near to the giant mass of Jupiter, would be forced by his

attraction (under ordinary circumstances) into an orbit having its aphelion not very far from the scene of the encounter.

Now it has been shown that Comet I, 1866, and the meteor-system associated with that comet, travel close past the orbit of the planet Uranus. The ascending node of the comet's orbit, in fact, is quite close to the orbit of Uranus, so that it is probable that the comet approaches that orbit more nearly even than the known members of Jupiter's comet family approach the orbit of their ruling planet.

We must look then on Uranus as the planet by whose attraction the comet was forced to take up its present orbit, and astronomers having traced back the history of the comet, and that of distant Uranus, have found that in the year 126 A.D., Uranus and the comet were so close that for a brief time, the comet was more under the influence of the planet's attraction than under that of the Sun's. At this time it was then that the comet was found to travel on its present orbit. And it was by the merest accident that this orbit passed so near as it actually does to the Earth's orbit. Now where were the meteors when that encounter took place? If they had been straggling far behind the comet like the major part of the system at the present time, they would not have been brought under the influence of Uranus as the comet was, and their paths would not afterwards have shown any approach to identity with the comet's orbit. The fact, then, that there is that singular identity in the track of the comet and of the meteors, shows conclusively that every particle of matter constituting the meteors must originally have been in the immediate neighbourhood of the comet.

It is then since the introduction of the comet into our system that the meteoric ring has been formed. Up to its encounter with Uranus, the comet and the meteoric matter had been collected within a space of very small dimensions indeed, compared with the present dimensions even of what we term the condensed part of the meteor-system. About this we may feel absolutely certain. When we inquire, however, how the dispersion came about, we find ourselves surrounded with difficulties. Passing over the physical distinctions which seem to dissociate the meteors from their cometic companion, it is by no means easy to explain, in accordance with the laws of motion, the enormous extension at present attained by the meteoric system. If we suppose such a diversity of distance between Uranus and the various parts of the meteor-system at the epoch of encounter, as would result in differences of velocity, sufficing to account for the present dispersion of the system, it becomes

difficult as already shown, to explain how it was that the whole of the system was forced into the same (general) orbit. If, on the other hand, we assume a very close condensation of the meteoric particles, it becomes by no means easy to understand the dispersion of the system along an orbit whose circumference is upwards of 4000 millions of miles in length, in the comparatively short interval (1743 years) which has elapsed since the system was first forced to follow its present course.

We seem almost driven to the conclusion that some other force than gravitation has been at work in causing the dispersal of the meteoric particles.

EVAPORATION FROM PLANTS.

BY M. P. P. DEHÉRAIN.*

In this memoir it is endeavoured to be shown, that—(1.) Evaporation of water from leaves takes place under conditions different from those which determine the evaporation of an inert substance, for it occurs in a saturated atmosphere.

(2.) That this evaporation is specially determined by light.

(3.) That those luminous rays which are efficacious in causing leaves to decompose carbonic acid, are also those which favour evaporation.

A leaf of wheat weighing 0·390gr. is fixed in an ordinary experiment tube by means of a split cork, and at one o'clock the apparatus is placed in the sun; at half-past one o'clock the tube is weighed, and it is found that a condensation has taken place weighing 0·141gr.; at two o'clock the augmentation of the weight is 0·130gr., and there are thus in the tube 0·271gr. of water at the moment the leaf is replaced. At half-past three o'clock, after fresh exposure to the sun for half an hour, the augmentation is 0·121gr., and thus the quantity emitted has been pretty constant in spite of the presence in the tube of a notable quantity of liquid.

Arranging a similar tube furnished with cotton-threads dipping in water, it was found after three hours to contain 0·086gr. water, but after four hours' exposure to the sun the quantity was still 0·086gr.

The quantity of water emitted by plants varies singularly

* *Comptes Rendus*, August 9th, 1869.

according to the species of the plant and the age of the leaves, but the most effective agent in inducing evaporation is the light, as the subjoined table shows, in which the quantity of water stated has reference to 100 parts by weight of the leaves. The naturalist Guettard recognized these facts in 1748 and 1749.

QUANTITIES OF WATER EVAPORATED IN ONE HOUR BY LEAVES.

	Light.	Temp.	Weight.	Water collected.	Per centage of water to weight of leaves.
		°	gr.	gr.	gr.
Wheat (Exp. 1.).....	Sun	28	2·410	2·015	88·2
	Diffused light	22	1·920	0·840	17·8
	Darkness	22	3·012	0·42	1·1
Barley (Exp. 2.).....	Sun	19	1·510	1·120	74·2
	Diffused light	15	1·215	0·210	18 0
	Darkness	16	1·342	0·832	2·3
Wheat (Exp. 3.).....	Sun	22	1·850	1·330	71·8
	Darkness	16	2·470	0·070	2·8
„ (Exp. 4.).....	Sun	25	1·750	1·320	70·3
	Diffused light	22	1·810	0·110	6·0
	Darkness	22	1·882	0·015	0·7
„ (Exp. 5.).....	Sun*	15	0·171	0·168	99·0
	Darkness	15	0·171	0·001	0·6
„ (Exp. 6.).....	Sun†	4	0·170	0·185	108·0
„ (Exp. 7.).....	Sun‡	15	0·180	0·170	93·0

These last experiments were made with a tube in a jacket traversed with a current of water of 15°, or containing water cooled with ice, or an athermanous solution of alum, and are particularly decisive. It will be observed in Experiment 6, that in the midst of the ice water the leaf emitted a notable quantity, more than its weight and greater than under ordinary conditions. This was without doubt on account of the vapour being better condensed.

All the luminous rays are not equally efficacious in determining the decomposition of carbonic acid by the leaves. It is known that the yellow and red rays which have least action on photographic paper, operate, on the contrary, most intensely on leaves in preventing this decomposition; whilst blue and green rays decompose nitrate of silver, and are without action on leaves. It was therefore interesting to ascertain if the luminous rays which determine the decomposition of carbonic acid, are equally efficient in promoting evaporation. To ascertain this the jackets of the tubes were filled with coloured solutions, and the leaves were plunged in an atmosphere

* Tube with a cold water jacket. † Surrounded with melting ice.
‡ Alum solution.

rich in carbonic acid, as the experiment was made with leaves adhering to living plants whose transpiration was to be determined. The quantity of carbonic acid decomposed in an hour by a leaf of wheat, weighing 0·180gr. in an atmosphere containing 38·8 per cent of that gas, was 7·7cc. when the jacket contained a yellow solution of chromate of potash; 1·5cc. when it contained a blue solution of ammoniacal sulphate of copper; and 0·3cc. when it contained a violet solution of iodine in sulphide of carbon; and the quantities of water evaporated in an hour under these conditions were 0·111gr., 0·011gr., and 0·000gr. respectively.

At a temperature of 37° (C.) a leaf weighing 0·172gr., in an atmosphere containing 22·2 per cent. of carbonic acid, decomposed 15·1 under influence of red light obtained by a solution of carmine in ammonia, and emitted 0·9, when a green solution of chloride of copper was employed.* At the end of the last experiment the carbonic acid was increased from 22·2cc. to 28·1cc.

The quantity of water evaporated in one hour from a leaf of wheat weighing 0·175gr., was 0·111gr. with the yellow solution, and 0·011 with the blue one. A leaf weighing 0·172gr., at a temperature of 38°, evaporated 0·161 under the red solution, and 0·10 under the green one.

Thus the luminous rays, which are efficient in determining the decomposition of carbonic acid by leaves, are likewise efficient in preventing evaporation.

I will add, in conclusion, that I have also confirmed the exactitude of an ancient observation of Guettard, who remarked that the upper surface of leaves, the part hard and smooth, is that which evaporates most water, and we know, from the labours of M. Boussingault, that they likewise decompose the largest quantity of carbonic acid.

M. Dehérain promises to communicate further observations on the nature of the gases disengaged by plants under the influence of different luminous rays.

* We do not exactly understand these statements. The table is not clear.

THE HETEROGENIST CONTROVERSY: NEW FORMS OF ASPERGILLUS.

M. Victor Meunier writes as follows in "Cosmos,"* in a paper entitled, "On Two New Species of Aspergillus":—

"The new species which are the subject of this note derive a certain interest from the circumstances under which they came under my notice. These plants were produced in two glass globes, only communicating with the atmosphere by the narrow opening of a long drawn-out and recurved neck. Anyone knows that by means of vessels of this description the most famous experiments of M. Pasteur have been made, and those chiefly by which he has opposed the Heterogenists. According to this chemist, when these globes are partly filled with a putrescible liquid, and have been in a state of ebullition long enough to kill any organized bodies they may contain, no living thing subsequently makes its appearance, because the curves of their necks stop the passage of germs from the external air. And this, observes the said chemist, proves that the products attributed to spontaneous generation are due to germs disseminated in the atmosphere. 'Never,' he exclaimed in the conference at the Sorbonne, 'can Heterogeny survive the blow which it receives from this experiment.'

"Now, it is under those conditions in which, according to M. Pasteur, nothing living ought to arise, that two vegetable species hitherto unknown to microscopists have been obtained.

"The first in point of date was produced in a globe of three hundred cubic centimetres capacity, one quarter filled with human urine, which was made to boil for five minutes, and, according to M. Pasteur, that is three minutes more than suffices to render sterile urine contained in a vessel with a sinuous neck. This globe, as well as the whole series of which it formed part—of which we say nothing at present—was prepared on the 18th of September, 1865. On the 15th of the following November, that is to say after the lapse of fifty-seven days, it contained two floating clots (*îlots*) of vegetable matter. One had a circular form, bluish in the middle, whitish at the circumference. It was composed of mycelium of aspergillus, and at various spots, in the midst of articulated and forked threads, were seen heads in full fructification, shaped like the rose of a watering-pot. It was a species allied to *A. Pouchettii*, or a simple variety thereof.

* August 21, 1869.

"The second clot was of irregular shape and greenish colour. It was also formed by an aspergillus, much smaller than *A. Pouchettii* and very much branched. In the last named the heads are spherical, while in that of which we speak they were pear-shaped and depressed. Thus it was a new form of aspergillus.

"Besides the two clots just described, the liquid contained a great number of dead bacteriums, globules of yeast, often in pairs, spores of aspergillus, and undetermined crystals. I submitted the plant to M. Pouchet, who wrote back in 1865, 'This is a new plant. I have never seen it before, and it is assuredly a new species. If you do not find a better name for it, you can call it *minutus*, or *ramosus*, or *corymbosus*, according as you may wish to indicate its smallness or the ramification of its fertile extremities.'

"Notwithstanding my deference for this learned and excellent friend, I have not adopted any one of the names he suggested. I have dedicated this new species to M. Pasteur, whom it may lead to reflect still further on the properties of sinuous tubes, and I inscribe it in science as *Aspergillus Pastorii*.

"The second species I found in a globe which formed part of a series prepared in April, 1866, and I may observe that for a purpose which need not now be specified, the necks of these globes were much longer than usual, and that after descending to the base of the apparatus, turned up again to the level of the first curve to descend once more to the level of the lower curve. Each of these vessels contained about 75cc. of the liquid employed by M. Pasteur in his experiments before the Spontaneous Generation Commission, and which consisted of a decoction of one hundred grammes of beer yeast in a litre of water, boiled for three quarters of an hour. When introduced into the globes, this liquid was subjected to a fresh boiling of two minutes, in conformity with the proceeding of M. Pasteur on the occasion named. On the 10th of October, 1867, after 537 days, the only one of the globes which now concerns us contributed an abundant vegetation, and the fluid had acquired a dark tint. A microscopic examination showed this time another aspergillus, very contorted and gibbous, abounding in a fructification not resembling any other, and which it was impossible to regard as a variety of *A. polymorphus*. To the preceding characters it may be added that the divisions in the threads were very close together. This, like the preceding form, was submitted to M. Pouchet, who said it was an undescribed species, not known to investigators, and very curious. He added that he

was much astonished to see a form he had never before encountered. I have named this species *A. gibbosus*."

M. V. Meunier figures his *A. Pastorii* with slender curved and forked threads, the heads at their extremities being more like the rose of a watering-pot than can be the case with the rounded heads of *A. Pouchettii* of which he speaks. Some of the heads he figures are surrounded by discharged spores. The *A. gibbosus* is figured with some of the threads expanded at intervals into globular and oval bulbs. In one case a thread is surmounted by a large bottle-gourd-shaped bulb, out of which grows one somewhat similar but smaller, while from the bottom of the first bulb, on the left-hand side, there grew out three rounded cells in close contact. Another thread exhibits eight or nine of these expansions, one after the other, of which two have short stalks.

What reference these experiments really have to the spontaneous generation controversy, it is impossible to say from M. Meunier's description, because we can form no idea from general statements of the precise precautions taken to exclude germs. The size of the twisted necks, the care used in effectually cleaning the whole apparatus, and the exact circumstances under which everything was placed and examined, would all have to be known and considered before we could possibly tell how far these experiments really contradicted anything asserted by M. Pasteur. Moreover, it will strike everyone that if the theory of the Heterogenists is true, M. Pasteur ought not to be able to succeed in numerous experiments, made at various times, in preventing the growth of organisms under conditions similar to those employed by M. Meunier.

The only flaw we have been able to detect in M. Pasteur's experiments is that he has used powers too low to exhibit the most minute forms; but anything like M. Meunier's aspergillus would be conspicuously visible. Notwithstanding these objections we regard M. Meunier's experiments as interesting; though he would have acted with more dignity, as well as more civility, if he had abstained from connecting M. Pasteur's name with one of his so-called "new species."

With reference to the novelty of the species, we do not consider MM. Pouchet and Meunier justified in so readily assuming that new forms of aspergillus ought to be admitted as new species. Indeed, while so little is known about such microscopic organisms, specific names should be given very sparingly, and not hastily assigned to any form that cannot be easily reproduced from its own spores.

If M. Meunier's precautions for excluding the germs alleged by M. Pasteur to be the cause of life appearing under such conditions, are deemed to have been sufficient, then comes the question of whether the boiling he mentions is really able to destroy all germs that the fluid may have contained, though from M. Pasteur's experiments such would seem to be the case.

The spontaneous generation controversy is escaping from direct solution through the extreme minuteness of germinating particles. It seems almost impossible to place their exclusion beyond dispute, without hermetically sealing the vessels, and thus stopping development.

It is a great pity that M. Pasteur and his opponents could not agree to a conjoint method of making their experiments. It cannot be expected that either party should accept mere statements of the other, although made in good faith. So much turns upon minute attention to detail, that M. Pasteur, falling back upon his own experience, may reasonably suspect want of accuracy when others state that they have made similar trials with different results. It is only when other observers have met with organisms too minute for discovery with the power he has employed, that he can be fairly required to doubt his own results; which must be accepted, *as far as they go*, until good reason to the contrary is shown.

ASTRONOMICAL NOTES FOR OCTOBER.

BY W. T. LYNN, B.A., F.R.A.S.,

Of the Royal Observatory, Greenwich.

VENUS will be visible, low in the sky, for about an hour after sunset throughout the month. She will be very near the bright star, Antares, on the 19th. Early next month her southerly motion will be exchanged for a northerly one, shortly after which she will begin to remain visible for a considerably longer time.

JUPITER will be a magnificent object during the whole night, in the constellation Aries, not far from the star δ, which is of only the fourth magnitude. The following table gives a list of those phenomena of his satellites which will occur before midnight. The eclipses take place a very short distance to the left hand of the planet as seen in an inverting telescope, the first and second satellites being, at their reappearances, behind him, and therefore not visible.

A complete eclipse, however, of the third satellite may be observed on the 21st, if the night be fine; and it is proper to warn intending observers that the times here given from the "Nautical Almanac" for that satellite may be several minutes in error. Shortly after emerging from the shadow, it will disappear behind the planet itself. All the other satellites will then be on the same side of Jupiter, the fourth at a very considerable distance, about three times that of the second, from him.

DAY.	SATELLITE.	PHENOMENON.	MEAN TIME. h.	m.
Oct. 4.....	II.....	Occultation, reappearance	10	9
„ 6.....	I.....	Transit, ingress	10	52
„ 7.....	I.....	Occultation, reappearance	10	10
„ 8.....	I.....	Transit, egress.....	7	29
„ 11.....	II.....	Eclipse, disappearance ...	8	48
„ 14.....	III.....	Occultation, disappearance	7	27
„ 14.....	III.....	Occultation, reappearance	8	56
„ 14.....	I.....	Eclipse, disappearance ...	9	8
„ 14.....	I.....	Occultation, reappearance	11	55
„ 15.....	I.....	Transit, ingress	7	3
„ 15.....	I.....	Transit, egress.....	9	14
„ 18.....	II.....	Eclipse, disappearance ...	11	24
„ 20.....	II.....	Transit, egress.....	8	48
„ 21.....	III.....	Eclipse, disappearance ...	8	47
„ 21.....	III.....	Eclipse, reappearance.....	10	35
„ 21.....	III.....	Occultation, disappearance	10	45
„ 21.....	I.....	Eclipse, disappearance ...	11	3
„ 22.....	I.....	Transit, ingress	8	47
„ 22.....	I.....	Transit, egress.....	10	58
„ 23.....	I.....	Occultation, reappearance	8	5
„ 27.....	II.....	Transit, ingress	8	49
„ 27.....	II.....	Transit, egress.....	11	3
„ 29.....	II.....	Occultation, reappearance	6	2
„ 29.....	I.....	Transit, ingress	10	31
„ 30.....	I.....	Eclipse, disappearance ...	7	26
„ 30.....	I.....	Occultation, reappearance	9	48
„ 31.....	I.....	Transit, egress.....	7	7

THE MOON.—It may be just mentioned that New Moon takes place on the afternoon of the 5th, at 2h. 20m.; First Quarter at

10h. 3m. on the morning of the 12th; and Full Moon at 1h. 57m. on the afternoon of the 20th. The week commencing with the 8th or 9th will therefore be the best for observing objects on the lunar surface. No occultations of stars by the Moon will occur of sufficient interest to make it desirable to mention them here.

SECCHI'S SPECTRAL OBSERVATIONS.—Father Secchi has lately published in the "Comptes Rendus," of the French Academy, several papers on spectrum analysis as applied to the heavenly bodies, the principal points in which we shall endeavour here to lay before our readers.

In the first place he has analysed the reflected light proceeding from several of the planets, and has found that of Uranus in some respects peculiar. The spectrum contained two strong absorption bands, the strongest near the line E, the narrower close to F, each on the most refrangible side of those lines. There was also a remarkable interruption in the spectrum, which extended over the whole of the yellow space, so that the line D, so readily seen in other cases, could not be perceived at all. Of course it must not be forgotten, in speaking of the spectrum of this planet, that its whole light is extremely feeble. It happened that when the observation in question was made, this was increased by the near neighbourhood of the Moon.

His spectroscopic observations of the variable star R Geminorum, are also possessed of interest. They were made in the middle of February last, when that star arrived at its last maximum of brightness,* being between the sixth and seventh magnitudes. The spectrum resembled that of the well known T Coronæ, which suddenly increased so remarkably in brightness in the month of May, 1866. Bright lines were seen also in R Geminorum, partly isolated, partly on a luminous ground. The line F was very brilliant, shining on dark ground; then came a luminous part of the spectrum, upon which the magnesium line, or one of those very near it, shone out; then a yellow part, containing a double bright line, and finally, the hydrogen-line C, which only occasionally flashed up, and terminated the spectrum.

But the most interesting of Father Secchi's observations, are those which relate to different parts of the Sun, particularly those obtained by directing the spectroscope to the solar spots. Mr. Huggins had already, so early as April, 1868,† observed the spectra of some of these, found the dark lines considerably thicker

* Its period being about 371 days, it will not reach another until next March.

† "Philosophical Transactions," 1868, p. 553.

than in the ordinary solar spectrum, and shown that this did not merely arise from the greater feebleness of the light, but that the light proceeding from the umbra of the spots had really suffered a more powerful absorption.

Secchi took advantage of a particularly good opportunity to make an accurate examination of a very beautiful group of spots which were seen early in April of the present year. The form of this group, which he observed through an exceptionally clear atmosphere, on the 11th, 12th, and 13th days of that month, was a double nucleus of oval form, surrounded by a penumbra, and accompanied by a number of smaller spots, of tail-like shape. The two nuclei were separated by a very narrow and brilliant vein or bridge of light, which passed also right across the penumbra.

It was noticed, as had also previously been done by Mr. Huggins, that the increase in the thickness and blackness of the dark lines of the spectrum proceeding from the umbra of the spot, was very different for different lines; in some (particularly the hydrogen lines C and F) being scarcely, if at all, greater than would be due to a spectrum of feebler intensity, but in others being extremely strongly marked. Mr. Huggins especially noted this in the case of a small group of lines near *b*, marked by Kirchhoff, as coincident with lines of chromium; Father Secchi in that of some lines belonging to the barium and calcium groups. The most original part of Secchi's observations related to some darker bands or zones, which he perceived in the spectra proceeding from the spots. Five of these zones were noticed; one midway between the lines C and D, where a mass of nebulous lines produced the appearance of an obscure band spreading itself out; a second in the red part of the spectrum, near C, towards B; a third near D; a widish space in the green; and a fifth band in the blue.

Another very curious circumstance was, that the hydrogen lines C and F not only almost completely disappeared in the spectrum of the penumbra, but were converted, when the above-mentioned bridge of light connecting the two nuclei was brought upon the slit of the spectroscope, into luminous lines. Still more remarkable was the appearance of several luminous rays, in groups of two, upon the dark ground of the obscure zones just described.

Thus has the spectroscopic examination of solar spots established very special claims to attention; and Secchi remarks that it is impossible to observe them without being reminded of the spectra of some of the fixed stars, particularly that of the variable star, *α* Orionis. He goes on to say that he considers it probable that

if the Sun's light was in every part the same as that proceeding from the penumbræ of the spots, its spectrum would be like that of Aldebaran or Arcturus; whilst if it was the same as that from the nuclei of spots, the spectrum would resemble those of *α* Orionis and *o* Ceti.* These stars are variable, as are the majority of those whose spectra contain extended absorption-bands. Hence Secchi draws the conclusion that *the solar spots owe their origin to causes similar to those which produce the phenomena of the variability of the stars.* Theorizing has already been at work in this connection, but we forbear, at present, to enter into its suggestions. Whilst it is impossible for the thinking mind to avoid theorizing upon any new fact, or set of facts, brought before it; and whilst it is most useful to do so, both as giving additional interest to discovery, and suggesting desirable points for the employment of observation, it is necessary to be extremely cautious how far we carry our theories ahead of the facts of observation, to which only they can be legitimately applied.

THE SUPPOSED NEBULOUS RING ROUND THE SUN.—We quoted in our August number a reference made by Mr. Baxendell to some investigations into which he had entered a few years ago, tending to the conclusion that he had obtained evidence of the existence of a nebulous ring circulating round the Sun, which he supposed might become visible during a total solar eclipse, and thus produce the so-called "corona." It will be in the recollection of most of our readers that Le Verrier has shown the strong probability, from the observed disturbances in the motion of Mercury, that there exists a ring of small bodies within the orbit of that planet, and at about one-third of its distance from the Sun. These investigations cannot but be regarded as in some degree confirmatory of each other; but at any rate, as that of Mr. Baxendell does not seem to be anything like so generally known as it should be, we believe that a short account of it here will not be unacceptable. It was communicated to the Literary and Philosophical Society† of Manchester on the 8th of March, 1864, and arose out of an idea, suggested to the author by his long and elaborate investigations

* Secchi has *θ* Ceti; but Professor Zöllner, to whose account of these observations for the German "Astronomische Gesellschaft," I am here greatly indebted, remarks that without doubt this is a printer's error for *o* Ceti—the remarkable variable star to which we called attention in the last number of "THE STUDENT" as being now near its maximum brightness.

† Many of the contributions of this Society to the progress of science are extremely valuable, and are not always sufficiently known.

into the irregularities of variability of many of the variable stars, that an analogy might exist between this phenomenon and the changes in frequency of the solar spots, and that possibly close examination might show, besides the well-known long period (eleven years in length), "other changes of minor character and occurring in shorter periods."

With this view, Mr. Baxendell in the first place discussed the magnetical observations made at the Imperial Observatory of St. Petersburg, it being the most northerly station at which such observations had been made hourly for any lengthened period of time. Professor Lamont had shown that the same 11·1 year period existed in the variations of the magnetic declination, and in the frequency of the solar spots. Mr. Baxendell found in the magnetic declination variations, as shown in the St. Petersburg observations for the year 1848, a very decidedly-marked short period of thirty-one days. But when he came to compare the observations of subsequent years, he found they could not be represented by a period of that length. Not being able to believe, however, that anything so decided could be merely accidental, he tried other periods for those years, and at last discovered that a period was shown by all, but that it appeared to oscillate in amount, diminishing until the year 1856, when it was only about twenty-three days, and afterwards increasing, until, in 1859, it amounted to about thirty-two days. Here was at once a most remarkable additional result. The period was longest in duration about the very time when the number and frequency of the solar spots were greatest, and shortest when these were at a minimum. The author next discussed a large number of temperature observations, and found that these also exhibited, with unexpected distinctness, a variable period of the same greatest and least duration, and synchronizing almost exactly with the magnetic declination period in its times of maximum and minimum.

Mr. Baxendell was further led, by extending his investigations, to a much longer period, a little exceeding eighteen months in duration. It resulted chiefly from a discussion of the Greenwich magnetical observations from 1848 to 1859, and from a series of thermometrical observations made at Brussels and at Yakoutsk in Siberia. Of course, this period may at times more or less interfere with the shorter one, affecting it in the same way as the solar wave does the lunar in the phenomena of the tides. It may also explain some of the apparent exceptions to the law shown by the other.

The hypothesis proposed by Mr. Baxendell to account for these periodical changes appears to be extremely worthy of consideration,

and may best be expressed in his own words. It consists in supposing:—

"(1.) That a ring of nebulous matter exists differing in density or constitution in different parts, or several masses of such matter forming a discontinuous ring, circulating round the Sun in a plane nearly coincident with the plane of the ecliptic, and at a mean distance from the Sun of about one-sixth of the radius of the Earth's orbit.

"(2.) That the attractive force of the Sun on the matter of this ring is alternately increased and diminished by the operation of the forces which produce the solar spots, being greatest at the times of minimum solar spot frequency, and least when the solar spots are most numerous.

"(3.) The attractive force being variable, the dimensions of the ring and its period of revolution round the Sun will also vary, their maximum and minimum values occurring respectively at the times of maximum and minimum solar spot frequency."

In determining the length of the period of the ring, Mr. Baxendell adopted the values shown by the temperature changes, as being the more accurately determined; and these giving 29·12 days at the greatest and 29·08 at the least, it was easy to deduce that the greatest and least distances of the supposed ring from the Sun were 0·185 and 0·154 in terms of the mean distance of the Earth from the Sun. From this it resulted that the mean value was 0·169, or about fifteen millions of miles. It is remarkable that this is the very distance which Le Verrier considers the most probable as that of the intra-mercurial ring of small bodies, of which he conceives he has shown the existence by means of perturbations produced upon the planet Mercury.

As regards the important point of the nature of the varying attractive force, necessary to account for the variation in the length of the period of the supposed ring, Mr. Baxendell suggests that its matter is not improbably highly diamagnetic, and that being much nearer the Sun than any of the planets, of great bulk, small density, and very high temperature, it must be "very sensibly affected by the changes which take place in the magnetic condition of the Sun, and when interposed between the Earth and the Sun, it may act not only by reflecting and absorbing a portion of the light and heat which would otherwise reach the Earth, but also by altering the direction of the lines of magnetic force." It is well known that according to the most probable theory which has been proposed to account for the phenomena shown by comets, a magnetic force has

clearly manifested its existence. Nor can the oscillatory motion of the matter which has been seen to stream out from some comets towards the Sun, and the subsequent repulsion of quantities of matter, large in bulk, but small in mass, by which the tail appears to be formed, be well accounted for on any other supposition. So far then everything appears to be in consistency with Mr. Baxendell's hypothesis; and we can well conceive the nebulous ring alternately approaching and receding by some distance to and from the Sun, so as to vary the amount of attractive force exerted by the latter upon it.

A difficulty had occurred to the writer's mind, regarding not the existence of this supposed nebulous ring, but its becoming visible during a total eclipse and thus producing the corona. For the corona is, usually at least, nearly circular in form, and it appeared to him that the nebulous ring would, as seen from the Earth, be frequently, if not usually, elliptical in shape. On communicating recently with Mr. Baxendell himself on the subject, he (in a letter dated Manchester, Sept. 6th, 1869) stated that he had thought of this point, but conceived that it might well be that the apparent breadth of the greater portion of the nebulous ring considerably exceeded the apparent diameter of the Sun, and that therefore, from the way in which it reflected the Sun's light within it, the form of the corona thus produced would be usually sensibly circular. However, as the ring was probably irregular, when a *narrow* portion of it was interposed between the Sun and the Earth, the corona would really be in some degree elliptical in form. Now he remarks that this is by no means inconsistent with observation, and in particular Herr Grosch* found the corona, seen in the total eclipse observed by him at Santiago, on the 29th of August, 1867, to be actually elliptical, and estimated its breadth in the direction of the Sun's equator to be four-fifths of the Moon's diameter, whilst the breadth in the direction of the poles was only about one-third of that diameter. Mr. Baxendell further remarks in the letter referred to, that it had been objected to his theory, that the nebulous ring would not account for the rays or streamers which are often seen extending beyond the corona. "But," he says, "I regard them as being something totally different to the true corona, and unconnected with the ring of nebulous matter; and in reference to this point, the description of the rays and corona given by Herr Grosch is worthy of attention. He noticed that the light of the rays had a bluer appearance than that of the

* We gave a complete translation of Grosch's account of his observations in the March number of THE STUDENT, Vol. III. p. 128.

corona." It will be noticed by those who have read Herr Grosch's account, that the impression on his mind was in every way as if the rays were unconnected with the corona.

We regret that having, at the time of writing, not yet received complete and reliable accounts of all the observations of the American eclipse of last August, we must postpone for another month any reference to their bearing upon this interesting question. The subject of the corona will receive special attention on future occasions of a like kind, and as the prominences have been satisfactorily accounted for, no doubt this phenomenon will in time be so too. But the existence of Mr. Baxendell's supposed nebulous ring is of course a distinct question from its visibility during an eclipse. Further investigations in its connection are certainly very desirable, and doubtless will not fail to be made.

Variable Stars.—Eleven of the periodically variable stars, whose periods exceed a month in duration, will probably come to a maximum of brightness some time in the present month. Three of these, however, S Leonis, S Canis Minoris, and R Orionis, are not above the horizon in Europe at times favourable for observation. The following table contains the places, lengths of period, limits of magnitude, and probable days of greatest brightness, of the eight others, arranged according to length of period:—

NAME OF STAR.	R.A.	N.P.D.	PERIOD.	MAGNITUDE.		DAY OF MAX.
	h. m. s.	° ′	days.	Max.	Min.	
R Sagittæ.....	20 8 5	73 40	70·5	8·3	10·0	Oct. 5
T Capricorni	21 14 46	105 43	269·5	9	13	„ 28
R Ursæ Majoris ...	10 35 21	20 32	302·3	6	12	„ 19
T Serpentis	18 22 24	83 47	340·5	10·5	13	„ 3
R Piscium	1 23 53	87 48	345	7·4	11·8	„ 3
T Pegasi	22 2 30	78 6	364	9·1	12	„ 29
U Herculis	16 20 1	70 48	409	7·0	11·2	„ 20
R Cassiopeiæ	23 51 46	39 20	428·9	4·8	12	„ 28

Dr. Schmidt has again detected changes of magnitude in several small stars, the most remarkable of which is ζ Piscis Austrini, which Argelander had registered as of the fifth magnitude, and, of course, visible to the naked eye. Schmidt found that in 1864 it was scarcely so visible, and it is now fainter still, not exceeding the seventh magnitude. ("Astronomische Nachrichten," No. 1770.)

A NEW FORM OF VALENTINE'S KNIFE.

Those who have been in the habit of using a Valentine's Knife must often have felt the inconvenience of having to alter two screws in the adjustment of the blades, each screw modifying the effect of the other; and also the difficulty of causing an exact adjustment of the blades, when the only guide as to their proximity is the eye of the manipulator. These disadvantages have been, to a great extent, overcome by Mr. W. R. Gowers, of University College, in a new and very beautiful form of knife which he has invented, and which has been very well made by Mr. Hawksley, of Blenheim Street, New Bond Street. In it the blades, which are quite separate, are held together and adjusted by a single screw.

The blades are steadied by two pins, which are fixed to one of them and pass through the other; also by two strong springs, one on each side of the screw. These springs, tending to separate the blades, and being opposed by the screw, serve to maintain an excellent parallelism between the blades at all cutting distances. To facilitate their adjustment at a given distance, the head of the screw is graduated, and at one side of it projects a small indicator. The blades can then be placed at any given proximity with the greatest accuracy and ease, by turning the screw till any given degree corresponds with the indicator. One of the blades is fixed in a convenient wooden handle, and the other, with the mechanism, can be entirely removed, so that the first can be used as an ordinary knife when desired. All the metal part except the blade is gilt, and therefore there is no danger of rust from any moisture which may be accidentally left upon it. The instrument works well, and is very strong and steady. Mr. Gowers, by his clever invention, has remedied a great difficulty which has been experienced by microscopists, and we cannot but feel that they will recognize its importance by adopting it in preference to that at present in use.

ON THE STUDY OF ILLUMINATION, COLOUR, AND SHADOW ON THE MOON'S SURFACE.

BY WILLIAM RADCLIFF BIRT, F.R.A.S.

Mr. Browning, in his remarks on Aristarchus, Herodotus, and Linné, calls especial attention to the remarkable metamorphoses which lunar objects undergo with different angles of illumination, and speaks of such as he has observed in Linné and Aristarchus as not having been detected previously. Beer and Mädler, if I remember rightly, give several instances of the entire obliteration of craters under high lights, and emphatically say of Maginus, "The full Moon knows no Maginus." The deep crater Geminus is perhaps a still more remarkable instance, the southern part is entirely lost as the Sun attains its meridian altitude, the outline of the northern remaining visible (see "British Association Report," 1859, Transactions of the Sections, pp. 30—33). I have a series of drawings made in 1859, giving the transition state as well as the different aspects under different angles of illumination. From such exceedingly striking evidence, the object returning—if the expression may be allowed—to the same state, lunation after lunation, a state of "fixity" may not only be reasonably suspected, but by some considered as fully proved. It is, however, important to bear in mind Chevalier von Haidinger's remark, "That no qualities of matter or force, except those known at present, can be admitted in explaining [these] phenomena." As we have no observational or experimental knowledge of a fixed state in the material universe, those cosmical bodies which have reached the Earth, bearing evidence of evolution and change within their limits as well as the Moon during its anterior history, the epoch at which its surface arrived at a state of "fixity" being unknown. We can only assume that such is the case now, from the absence of the observation of phenomena capable of proving that the opposite exists. Assuming, therefore, the truth of the theory of "fixity," the surface of the Moon must be unalterably in the same state, *i.e.*, not the slightest change of any kind takes place upon it. Upon this rigidly fixed surface the Sun rises, culminates, and sets, producing the mean luni-solar day of 354 hours, 22 minutes, which is succeeded by a night equally long. Upon the Earth the presence of sunlight occasions changes in its atmosphere, and on its surface. The progression of diurnal temperature is well-marked, its maximum corresponding with a certain position of the Sun in the heavens. So far as regards the Sun's place in the sky,

the same phenomena occur at the Moon, viz., sun-rising, southing, and setting, which, as on the Earth, produce *apparent* differences in the appearances of objects, the sides on which the Sun is shining being strongly illuminated, the opposite sides being in shadow. As the Sun pursues his apparent course in the heavens, their appearances alter, the bright side of an object becoming less so, and after awhile, that which was in shadow shines by reason of the illuminating solar rays. The two series of phenomena, on the Earth and Moon, are parallel. The surface of the earth consists of different materials; here a large expanse of water exists; there an immense sandy desert; long chains of mountains stretch across continents, their tops capped with snow, their sides clothed with forests; many tracts consists of undulating surfaces, having a superficial covering, the result of agricultural and pastoral operations, which vary in colour with the seasons; these surfaces are dotted with numerous cities, towns, and villages. Experience is silent as to the appearances which these diversified surfaces exhibit at the distance of 240,000 miles. So far as analogy may assist us, we can only take surfaces of very limited extent, such as distant landscapes, presenting varieties of foliage and buildings which we may observe with the telescope,* under differences of solar altitudes and azimuths—for example, we may select a distant building bearing in a certain direction from the point of observation. This building will present the colours due to the materials of which it is composed, distance will however reduce the tone of this colour to a variety of grey. At sunrise the side of the building which is directed towards the east will *shine* by the reflection of the Sun's rays, the *strongest* reflection being dependent upon the altitude and azimuth of the Sun with respect to it, and its bearing from the point of observation. At sunset its appearance as regards illumination will be entirely changed, the lights and shadows being thrown in different directions according as the altitudes and azimuths of the Sun have altered, intermediate changes having occurred during the day.

The principle which we are desirous of strongly insisting upon is this, that any appearance of the building dependent upon any given altitude and azimuth of the Sun will *always* be the same with that altitude and azimuth, and generally as any given altitude and azimuth can occur *but twice in the course of a year*, if the building remain in precisely the same state during a year, it will, when the Sun attains the same altitude and azimuth present precisely the

* The reader is requested to suppose that the objects observed are *inaccessible* and can only be seen by the aid of the telescope.

same appearance. If, however, any change in the building should supervene between two similar altitudes and azimuths; for instance, a portion which overshadowed a wall being removed, its appearance with the same altitude and azimuth would be proportionally altered. This would be manifestly a real and not an apparent change.

We have here supposed a building whose bare walls receive and reflect the light of the Sun, the shadows of the projecting portions being well marked, and consequently the gradations of its appearance from morning to night, and, from season to season, capable of being accurately traced. The observer, however, would, after a lapse of time, notice a change quite independent of illuminating angle: as the surface became abraded by the action of meteoric agents *its colour would gradually and slowly alter*, and this alteration although scarcely perceivable, except after a long interval of time, would indicate a real change on the surface of the building and not one of a merely apparent nature.

If the building we have selected were constructed of very white stone, it would stand out in the landscape as a bright object, and if some sprigs of ivy were planted at the base of the walls, while they continued of diminutive size, its general aspect would not be interfered with, but as their growth proceeded, the brightness of the object would be impaired, the upper portions only would be visible, the lower becoming confounded with the foliage around, until the wall should be finally covered, when it would no longer present those gradations of appearance noticed with certain altitudes and azimuths; the upper portion of it indeed might still be visible, but its appearance would be greatly altered by reason of its superficial covering.

Although in the example just adduced the building itself has undergone no *real* change, its surface only has been *covered*, it may have been slowly, or even more rapidly, still the appearance is one that cannot be referred to the mere reflection of light; the brightness has disappeared and a sombre hue substituted, a change quite capable of being recognized by an observer at a considerable distance.

There is one element exceedingly necessary in observations of this kind. To determine all the gradations of appearance dependent upon illuminating angle, TIME is requisite. To observe the slow and gradual change dependent upon meteoric action, TIME is of the last importance. To ascertain the still greater change of colour, and to watch the creeping up of the deeper tint as the ivy rears itself against the walls, TIME must be consumed; "the sound which to the

ear of the Student of Nature seems continually echoed from every part of her works is

TIME!—TIME!—TIME!

Transferring the objects of observation from a building in a rural landscape, to a mountain peak in a volcanic region, the same gradations of appearance—although upon a much grander scale—dependent upon solar altitudes and azimuths are observable; disintegration dependent upon meteoric agency becomes visible, but in a much less degree than apparent change resulting from the reflection of light. The results of phenomena that would completely overawe the beholder, were he on the spot, are recognizable only by some slight difference of tint, and much patient and unremitting observation would be necessary to make out—and that but imperfectly—the evidences of convulsions which would be patent could they be examined near at hand. The surface around a volcano emitting stones, scoriæ, and ashes, might become altered in tint according as they reflected more or less strongly the light falling upon them; and if the tint of this surface were previously well-known, as associated with every solar altitude and azimuth, the effects of the eruption would be perceptible by the change in the reflection from the surrounding surface.

On the Earth occasional obscurations of well-known features would occur by reason of the condensation of steam issuing from the volcano, and forming immense masses of cloud, which would reflect very strongly the Sun's light falling upon them in a suitable direction, while the opposite side would present a hue of inky blackness—phenomena that must be familiar to every one, but seen at a sufficient distance would appear only as a white or dark patch.

Applying the above remarks to the study of the physical aspe of the Moon's surface, one of the most important series of observa tions, clearly consists in the determination of the aspects of luna objects during the progress of the luni-solar day, as dependent upon the position of the Sun with regard to them. Seasonal changes of an apparent nature also take place during the luni-solar year, which contains about 346 terrestrial days, or 11·73 luni-solar days; the variations of aspect being precisely of a similar nature to those described, as affecting a terrestrial building, mountain peak, or any other object when viewed from a distance.

If any lunar object be fixed upon as suitable for such a series of observations, its aspect should be noted on every convenient occa-

sion. Observations of this kind are not difficult, but each should be accompanied with the Sun's altitude and azimuth *at the time;* the computation of these elements should be made as soon after the observations as possible, otherwise there is great danger of the work falling into arrear. The formulæ for computing the Sun's declination and altitude, also the longitude of the terminator—which is equivalent to that of sunrise at the equator on the meridian of the object—will be found in the Report of the British Association for 1868. For the azimuth the ordinary formulæ given in most works on navigation may be used. The hour angle employed in computing the Sun's altitude, may be taken as equivalent to 90° minus the number of hours elapsed from sunrise at the equator converted into arc, 177h. 11m. being equal to 90° or 1°= 118·12m.

If, after a considerable number of observations are obtained and arranged in order of Sun's dec., alt., and azimuth, the *same aspect is always presented with the same altitude and azimuth,* the logical inference is that in the interval between the first and last observations no change whatever has taken place; but if any difference should be noticed in the *form of the shadow,* or in the *colour* of the surface, a change has undoubtedly supervened of a character inexplicable on the principle of the reflection of light.

Next to the determination of aspect, the observation of colour is highly important—a branch which has not yet been seriously taken up—until we obtain good and trustworthy records of the colour of objects, especially under different solar altitudes and azimuths, it is clear that we shall be unable to determine if the colour, casually observed, be constant or not, or whether it undergoes changes dependent upon solar altitude and azimuth. Secular changes of colour, if such exist, can only be ascertained after well-determined series of colour throughout the luni-solar day and year are known. Numerous records of colour, expressed in the scales of brightness of Schröter, Lohrmann, and Beer and Mädler exist, from which, in some cases, recent determinations differ; but it is obvious that, for want of determinations referred to the Sun's altitude and azimuth, such differences must be vague and unsatisfactory.

In connection with colour we have those remarkable and mysterious phenomena known as "white spots." In many instances they occupy the sites of craters entirely obscuring (?) the crater-form, in others a connection with craters is not apparent; in such instances they appear only as round white spots on portions of the surface, which, under very oblique illumination (low solar altitudes)

manifests not the slightest difference from the immediate neighbouring parts. They appear to be a class of object strictly *horizontal*, so that the effects above described, in the case of a building or mountain peak resulting from illuminating angle, does not apply to them, inasmuch as the reflected light is not from a surface inclined at any angle to the horizon. Whether they invariably appear with certain altitudes and azimuths is not known; it is consequently very desirable that they should be carefully observed during the progress of the luni-solar day, the degree of brightness registered with the Sun's altitude and azimuth, and also the altitude and azimuth at which they first appear, and at which they disappear.

Shadow reveals many interesting features of the lunar surface, bringing out minute details which would otherwise be quite unrecognizable. The shadow of an object is manifestly in the opposite direction to that of the luminary, the light of which is obstructed by it. In some cases small and evanescent objects may be concealed by the shadows of larger objects in their neighbourhoods, and by the time the shadow has receded from them the strong light reflected from the contiguous surface renders them invisible. Such objects can only be observed when the shadows fall on one side of them, their visibility being evidently connected with certain solar altitudes and azimuths, which should be determined especially for the epochs of their disappearance.

Long narrow shadows often reveal the existence of faults, landslips, and objects which have resulted more or less from subsidence. In cases of faults, or steppes, the opposite illumination brings out the true character of the object; in one case the steep face of the fault being in shadow, in the other it is fully illuminated. The interior of many of the larger craters are terrace-formed, and it may be questioned whether the terraces have resulted from successive deposits of solid materials ejected from a central vent, or from subsidence within the confines of the ring. The study of shadows of terraced formations is very instructive, as, after a lapse of time, it may aid in determining if those portions of the Moon's surface, in which we might expect stronger evidences of change, continued in a state of quiescence during the period of observation. The results of the study of one such ring, Copernicus for example, would amply repay all the labour that might be bestowed upon it in the three lines of observation above specified, viz., illumination, colour, and shadow. Professor Phillips strongly recommends that "This magnificent mountain should be carefully re-examined

on the basis of Secchi's fine drawing, for the purpose, amongst others, of determining exactly how many of the bosses and ridges bear cup-hillocks."

The observer, however, must not expect to discover marks of any great or mighty change. Nothing of the kind has yet been seen. Mr. Slack, in his "Notes on the Comparative Geology of the Earth and Moon," says, "May we hope that though the evidence is difficult to collect, we may ultimately discover that activities and energies are at work as vigorously in the quiet grey plains and in the glittering mountains of the queen of our night, as they are in the globe she illuminates with the borrowed splendour of her fascinating light." To obtain these results much patient, persevering, and unremitting observation is necessary, and, if indications should be afforded of only minute or scarcely appreciable changes, the observer should not be disheartened, for of one of the regions on our own globe—extending over 14,400 square miles English, one most nearly allied in its features to many a lunar district—Sir Charles Lyell speaks in the following graphic terms:

"We are here presented with the evidence of a series of events of astonishing magnitude and grandeur, by which the original form and features of the country have been greatly changed, yet never so far obliterated, but that they may still, in part at least, be restored to imagination. Great lakes have disappeared—lofty mountains have been formed by the reiterated emission of lava, preceded and followed by showers of sand and scoriæ—deep valleys have been subsequently furrowed out through masses of lacustrine and volcanic origin—at a still later date, new cones have been thrown up in these valleys—new lakes have been formed by the damming up of rivers—and more than one creation of quadrupeds, birds, and plants [Miocene, Pliocene, and Post-Pliocene], have followed in succession; yet the region has preserved from first to last its geographical identity; and we can still recall to our thoughts its external condition and physical structure before these wonderful vicissitudes began, or while a part only of the whole had been completed. There was first a period when the spacious lakes, of which we still may trace the boundaries, lay at the foot of mountains of moderate elevation, unbroken by the bold peaks and precipices of Mont Dor, and unadorned by the picturesque outline of the Puy de Dome, or of the volcanic cones and craters now covering the granitic platform. During this earlier scene of repose, deltas were slowly formed; beds of marl and sand, several hundred feet thick, deposited; siliceous and calcareous rocks percipitated

from the waters of mineral springs; shells and insects imbedded, together with the remains of the crocodile and tortoise; the eggs and bones of water-birds, and the skeletons of quadrupeds, some of them belonging to the same genera as those entombed in the Eocene gypsum of Paris. To this tranquil condition of the surface succeeded the era of volcanic eruptions, when the lakes were drained, and when the fertility of the mountainous district was probably enhanced by the igneous matter ejected from below, and poured down upon the more sterile granite. During these eruptions, which appear to have taken place after the disappearance of the [Lower Miocene] fauna, and hardly in the [Pliocene] epoch, the mastodon, rhinoceros, elephant, tapir, hippopotamus, together with the ox, various kinds of deer, the bear, hyæna, and many beasts of prey ranged the forest, or pastured on the plain, and were occasionally overtaken by a fall of burning cinders, or buried in flows of mud, such as accompany volcanic eruptions. Lastly these quadrupeds became extinct, and gave place to [Post-Pliocene] mammalia, and these in their turn to species now existing. There are no signs, during the whole time required for this series of events, of the sea having intervened, nor, of any denudation which may not have been accomplished by currents in the different lakes, or by rivers, and floods accompanying repeated earthquakes, during which the levels of the district have in some places been materially modified, and perhaps the whole upraised relatively to the surrounding parts of France."

THE PASCAL FORGERIES—STATEMENT OF M. CHASLES.

For a long time past the world has been astonished at the absurd spectacle of the French Academy of Sciences wasting its time at innumerable meetings in discussing an endless supply of manuscripts produced by M. Chasles, and purporting to be written by Pascal, Galileo, and various other philosophers, but which were obviously forgeries, and in many cases copies of matter that had been printed in various books. M. Chasles thought his bundle of rubbish would suffice to deprive Newton of his great discovery, and show that he was only a fraudulent copier of Pascal, to whom, according to the manuscripts, all the credit was due. Proof after proof was adduced by the sane portion of the Academy that the matter was fictitious, and whether it was compared with genuine documents in Italy or in

England, the result was the same—fresh evidence of fraud. With a credulity curious, but perhaps not uncommon amongst mathematicians, M. Chasles was insensible to the folly of his position. He seemed to think that the quantity of his documents proved the excellence of their quality, and now that the cheat is discovered, it appears that the celebrated academician was incautious enough to make a long series of costly purchases without the slightest evidence of the authenticity of his supposed treasures. His own story is that in November, 1861, an individual calling himself a "paleographic archivist," whose special business was extracting genealogies, began to supply him with the peculiar documents. M. Chasles wanted to obtain the whole collection, but the "paleographic archivist" said that their owner had brought them from America in 1791, took delight in looking them over, and would only part with them at his convenience. He would not tell where the treasures came from, lest others should outbid him for what remained; and he says "the great number of the documents, the names of their authors, the variety of matters—scientific, literary, and historical—on which they treated, and the perfect concordance which he recognised in them, left no doubt in his mind of the authenticity of their contents." He adds that the vendor always came to him between eleven and twelve in the morning, or between half-past five and six in the afternoon, that he never went to his house, or sent any one to him for any document.

The circumstances that awoke the mathematician out of his credulity was an investigation made at Florence into the authenticity of a pretended letter of Galileo, dated 5th of November, 1639, and which he had photographed for the purpose. When his faith was dissipated he had the "paleographic archivist" arrested by the Prefect of Police. At his abode some clean paper, some pens, one inkstand, and some fac-similes of isography were discovered, but no mass of documents, such as M. Chasles supposed him to possess. At first he refused to say where the collection was, and then he admitted that he manufactured them. In reply to further questions he said that about sixty came from the Comte de Menou in 1861, and some containing genealogies were obtained from the cabinet of M. Letellier about 1860. He declared that since 1861 he had manufactured more than 20,000 pieces, which he sold to M. Chasles. Well may the deluded *savant* exclaim, "Can we admit that a single individual could compose such an enormous mass of documents, on all sorts of subjects, especially when no primitive materials of books or fragments were found in his possession."

M. Chasles went on to say that the documents with which he had occupied the Academy were only a portion of what he received. Besides numerous series of Galileo, Pascal, Louis XIV., Labruyère, Molière, Montesquieu, Bouilliau, Mariotte, Robault, St. Evremont, Locke, Madame Sevigné, Rotru, Corneille, Lafontaine, Etienne Pascal, Madame Perier and her sister Jacqueline, Maupertuis, Fontenelle, J. Bernouilli, etc., there were 2000 letters, at least, of Rabelais, as many of Copernicus, Columbus, Cardan, Tartalea, Oronce Finé, Ramus, Budæus, Grollier, Nostrodamus, Calvin, Melancthon, Luther, Scaliger, Dolet, Michael Angelo, Raphael, Sir Thomas More, Charles V., etc. There were also numerous letters and poems of Clement Marot, unpublished mysteries and poems of Margaret of Angouleme, together with letters of Shakespeare, Cervantes, Petrarch, Dante, Boccaccio, Guttenburg, etc., etc. Earlier dates were not forgotten by the archivist, who provided letters of Julius Cæsar and other Roman Emperors, of the Apostles, St. Jerome, St. Augustine, Charlemagne, Alcuin, etc.

Certainly a more marvellous collection was never brought together, and it would be most remarkable if they were all the work of one forger, who did not know Latin, nor Italian, nor mathematics, nor any other science. There is, as M. Chasles winds up, still "a mystery to penetrate;" but can mystery be greater than his own preposterous credulity?

We wait for further information concerning this very singular affair.

ARCHÆOLOGIA.

THE CENTURIATION OF ROMAN BRITAIN.

Some of our Archæologists of late have been running into rather extraordinary theories. An elaborate paper by Mr. H. C. Coote, on what he terms "the Centuriation of Roman Britain," has recently been printed in the "Archæologia" of the Society of Antiquaries, which deserves some notice. Mr. Coote sets forth very clearly from the Roman writers on rural matters, the laws and regulations relating to the establishment of colonies; and his paper is useful in drawing attention to the works of Hyginus, Frontinus, and other authors, who are at present little studied or known. But there are no reasons for supposing that these laws and regulations were enforced in the distant provinces of the empire; and the application of the facts we obtain from these writers to Britain is

not warranted by the evidence brought forward by Mr. Coote. We do not find the boundary inscriptions to which he refers, or anything analogous to them, on the sites of the large towns in Roman Britain, such as Verulamium, Camulodunum (which was a colony), Uriconium, etc.; but the stones which Mr. Coote considers to be colonial boundary stones marking individual property, are found almost entirely where they appear obviously to apply to work done—in other words, to building completed. One was found at Chester, and one at Caerleon, two of the great stations of the legions, precisely like those which are met with along the line of the great wall in the north, where they abound, as may be seen in Dr. Bruce's valuable work on the Roman Wall. Mr. Coote's novel interpretation is in opposition to the reading of all our best antiquarians, and as it appears, unwarranted by the fact; for, as just stated, these inscriptions are not generally found on the sites of the great towns, where land would be valuable, but they abound through the barren district of The Wall, where land for agricultural purposes was, and is, worthless, and where strength of fortification was the object aimed at.

T. W.

CORRESPONDENCE.

"WALENN'S IMPROVEMENTS," ETC.

To the Editor of THE STUDENT.

SIR,—In the September number of THE STUDENT, page 155, you are good enough to notice an invention by me that relates to electro-brassing.

The subject being of some importance, as evidenced by the interest evinced thereupon, I beg to acquaint you with the following points that bear upon the above-mentioned notice or article.

The article is apparently drawn up from the provisional specification. The sentence, "To precipitate these hydrates," is not quite in accordance with the context. In the final specification, the "improvement," stating that the liquid in the porous cell is higher than that next the article to be coated is disclaimed, as being too self-evident to be claimed as novel.

The brass and copper solutions described in this specification are eminently useful for practical purposes; they are not liable to get out of order, remain constantly conductible, and will deposit brass of any constitution from absolute copper on the one hand to absolute zinc on the

other hand. When time is not an object, the porous-cell method of depositing is very applicable, especially to secure a good and adhesive coating on rough cast-iron.

The bi-sulphuret of carbon solution is applicable to colouring other deposits; its appearance is very beautiful.

The chief point, however, in this invention is the economy of power, and the solid character of coating occasioned by the prevention of the evolution of hydrogen gas during deposition. After carefully trying and considering several hundred experiments, undertaken since 1866, I have succeeded, against a deeply-rooted idea, in finding a perfect means of causing the deposit to be coherent and uninterfered with by minute bubbles of hydrogen.

Again thanking you for the favourable notice you have kindly accorded to my invention, and apologizing for troubling you with the above remarks,

I am, sir, your obedient servant,

W. H. Walenn, F.C.S.

74, *Brecknock Road, N., September 20th*, 1869.

LITERARY NOTICES.

Country Walks of a Naturalist with his Children. By the Rev. W. Houghton, M.A., F.L.S., Rector of Preston, on the Wild Moors, Shropshire. Illustrated with eight coloured plates and numerous wood engravings. (Groombridge & Sons.)—Mr. Houghton is well known to our readers as an able naturalist, well acquainted with the labours of others, and frequently adding to the store of knowledge by shrewd observation and well-directed research. His real acquaintance with the subject, and his enthusiasm in its pursuit, make him a capital guide for young folks, and the publishers have acted wisely in giving his "Country Walks" a very elegant form. There are ten "walks" in the series, beginning in April and ending in October. Two are assigned to April, three to the merry month of May, two to June, two to July, and one to October. This plan is a good one, because the young folks for whom the book is intended will know what to look for at various times of the year, though why the scheme should not have been extended to November and December we do not exactly see, and we feel sure Mr. Houghton could not want materials for the closing periods of the year. Birds, beasts, fishes, reptiles, insects, rotifers, infusoria, and plants, all have their share of attention, and the places and circumstances under which they may be found are well indicated in the pleasant gossiping narrative. The coloured plates add much to the beauty and interest of

the work, and each chapter ends with a clever tail piece, picturesquely engraved. The woodcuts are remarkably good, and altogether a prettier gift book could not be selected, or one more likely to be welcomed in the family circle. The following curious story of a frog is not, we think, generally known:—"You may think a frog would make a curious sort of pet, but a gentleman once kept a frog for several years quite domesticated. It made its appearance in an underground kitchen at Kingston, on the bank of the Thames. The servants, wonderful to say, showed him kindness and gave him food. One would rather have expected they would have uttered shrieks of terror and fainted away at the unexpected sight. Curiously enough, during the winter season, when frogs, as a rule, are lying asleep at the bottom of a pool, this frog used to come out of his hole, to seek a snug place near the kitchen fire, when he would continue to bask and enjoy himself till the servants retired to rest. And, more curious still, this frog got remarkably fond of a favourite old cat, and used to nestle under the warm fur of Mrs. Pussy, she in the meantime showing that she did not in the least object to the frog's presence."

Mr. Houghton and his party find the nest of the stickleback in one of their excursions, *apropos* of which he tells the following story:—"I remember, some years ago, having once taken a father stickleback away from his nest, and after putting him in my collecting bottle, I sat down to watch the result. Soon an invading army of other sticklebacks approached and attacked the nest, for the purpose of getting at the cluster of eggs it contained. They pulled it about sadly, till I began to be sorry for what I had done. I returned the captive parent to the water. At first he hardly knew where he was, and seemed confused, the result, no doubt, of his confinement in the bottle; but he was not long in coming to himself. He remembered his nest and the treasures it contained; he saw that devastating army all around it, and, recovering all his courage, the soldier-parent began an attack, now rushing at one and now at another enemy, till he was left alone on the battlefield, having thus gained, single-handed, a glorious victory indeed." Mr. Houghton also states that he kept some sticklebacks in a tank with a pike, and that the pugnacious and well-armed little fish soon became the master, and nibbled off part of the pike's tail. The pike once tried to swallow one, but, after getting him in its mouth, was glad to spit him out.

THE ENGLISH LANGUAGE, ITS GRAMMAR AND HISTORY; together with a Treatise on English Composition, and Sets of Exercises for the Assistance of Teachers and Students. By the Rev. HENRY LEWIS, Lecturer at the National Society's Training College, Battersea. (Edward Sandford.)—This is a clever little book, conveniently arranged, and containing a large amount of useful information, for the most part judiciously conveyed. We doubt the expediency of dividing all words into "notional" and "relational," and we might name a few other points upon which we do

not exactly agree with the author; but we decidedly like his work as a whole, because it would interest intelligent pupils, and teach them to *think*, and not, as in old-fashioned teaching, to get up what was called "grammar" by rote. The book is adapted either for schools or for private instruction, and solitary students may use it with advantage.

Home Influence; a Tale for Mothers and Daughters. By Grace Aguilar, author of "The Mother's Recompense," "Woman's Friendship," "The Days of Bruce," etc., etc. Twenty-fourth edition, with Illustrations by John Gilbert and Ellen Edwards. (Groombridge and Sons.)—There is something startling in the twenty-fourth edition of a popular tale. It shows the work in question to have established itself upon very firm foundations of sympathy and approval. In Grace Aguilar's case we cannot wonder at such a fact, as during her brief but active life she evinced not only remarkable literary ability, but precisely that tone of moral and religious feeling that commends itself to the majority of English families. "Home Influence" is considered one of her best, if not her best story; and though many authors have tried their hand in this peculiar class of fiction, since its first issue, no one seems to have achieved equal success; for, while the majority of tales written expressly for young people have had only an ephemeral existence, the work before us seems to flourish in perpetual youth. The publishers have acted wisely in giving this twenty-fourth edition a very handsome and attractive form. It is the first volume of a re-issue of Grace Aguilar's writings in crown octavo, with elegant illustrations and rich binding. Each volume of the series will, like the present one, be complete in itself. The "Mother's Recompense" is announced for October, and will be followed by "The Vale of Cedars," "The Days of Bruce," etc., etc., all in the same style. Criticism of works of this description would be foreign to our sphere, and we can only, therefore, mention them in general terms.

An Illustrated Natural History of British Moths. With Life-size Figures from Nature of each Species, and the more striking Varieties. By Edward Newman, F.L.S., F.Z.S., etc. (W. Tweedie.)—Mr. Newman's well-earned reputation is a guarantee for the general accuracy of this important work, which makes a large, handsome volume, clearly printed, and illustrated with a great number of wood engravings of unusual merit. We are glad to find that Mr. Newman, without any sacrifice of real science, has given his labours a popular form, by employing a simple style, and an avoidance of needless difficulties in his descriptions. Ten years ago, Mr. Newman tells us, he began the task of describing from nature our English caterpillars, and the Rev. H. Harpur Crewe commenced his description of those of the genus *Eupithecia*. All his own descriptions, as well as those of Mr. Crewe, are transferred to the present volume, and must enhance its value, and would have done

so to a still greater extent if they had been figured, as well as the moths to which they belong. English names are used throughout the work, wherever there are any; and this will greatly facilitate the popularization of the study, while, as the scientific names are also given, no difficulty in identification can result. We may observe, in conclusion, that we consider this book as an important addition to the scientific library.

NOTES AND MEMORANDA.

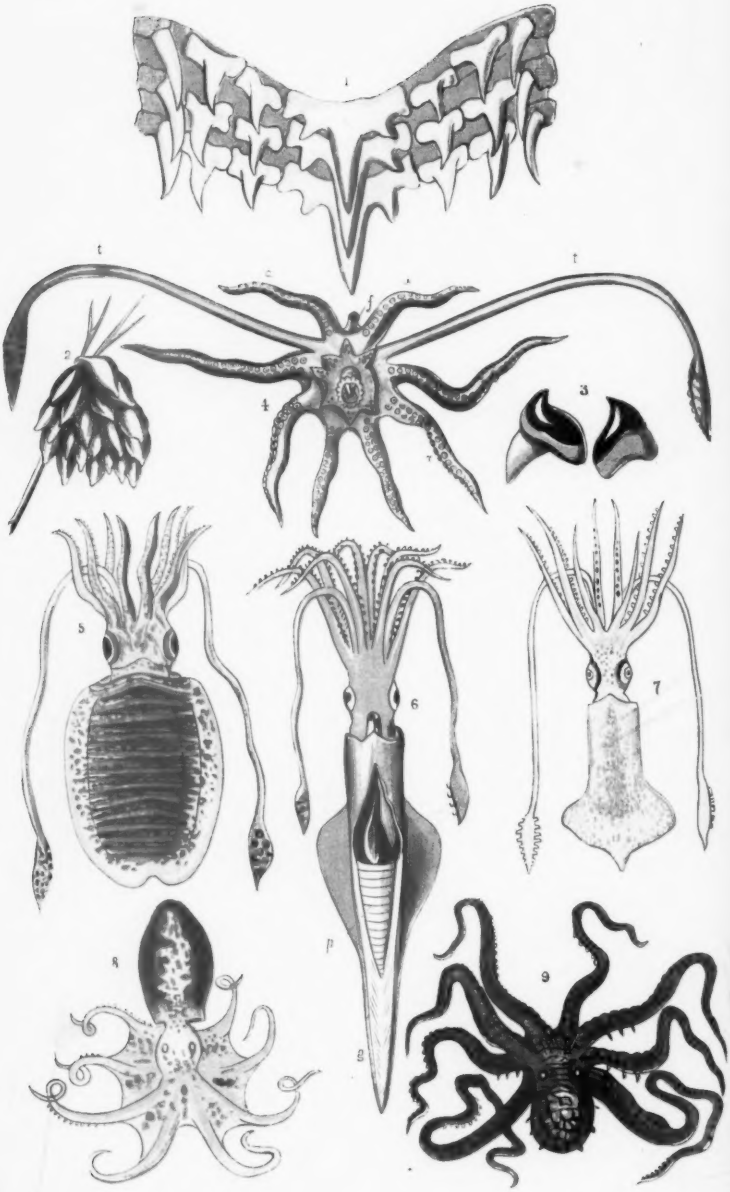
MEDICAL ELECTRICITY.—M. Abeille informs the French Academy that, when animals are dying from an overdose of chloroform used as an anæsthetic, the best mode of reviving them is by "electro puncture by means of the induction apparatus of Legendre and Moyen, on the cerebro-spinal axis." He says that the shocks should be given at the rate of ten in ten seconds, and that life sometimes reappears even after respiration has completely stopped, and no circulation can be detected.

ACTION OF CHLORAL.—M. O. Liebreich details, in *Comptes Rendus*, his experiments with chloral, which, he says, may be considered as a trichlorated aldehyde, and if dissolved in an alkaline liquid, it decomposes and forms chloroform. He wished to ascertain whether the chloroform produced in this way in animal bodies would exert its customary action. He administered hydrate of chloral first to animals and then to men, and obtained the effects of chloroform. He made a subcutaneous injection of 157 centigrammes of the hydrate in an epileptic insane patient, afflicted with sleeplessness and delirium. In five minutes profound sleep came on, and lasted four hours and a half; and, on waking, the patient took his usual repast. In another case, he gave a young woman, suffering from violent arthritis, two grammes of hydrate of chloral in a glass of water, which induced the anæsthetic state, so that curative means could be adopted without her feeling pain.

COAL ON THE CASPIAN SEA.—The Russians are reported to have discovered considerable deposits of coal on the eastern shores of the Caspian.

ORIGIN OF BACTERIUMS.—"Cosmos" states that Rototenow has been led by his investigations to believe that bacteriums, vibrions, and spirillum, are derived from the spores of fungi, and particularly from those of *Penicellium glaucum*. He states that the transformations may be readily seen if the spores are raised to a temperature of from 60° to 100° C.; that there is reason to think they spring from granules contained in the cellules of the mycelium threads, and these organisms are capable of passing into higher forms.

DEVIATION OF MAGNETIC NEEDLES.—M. Delaurier observes that "it is admitted that this deviation is greater in proportion as a current in the same vertical plane as the normal direction of the needle is brought near it; but this is only exact up to a certain point. By employing a magnetized needle 12 cc. long, the maximum deviation was at 3 cc. above the needle, with a current giving 45° as the angle of deviation. When the current is brought nearer the needle, the deviation diminishes gradually, and is only 30° when contact is only just avoided." He adds that he has tried needles of various forms, and currents of different intensities, with the same general result. The error of Savart and Biot he considers arose from their employing an apparatus which did not permit a close approach of the current to the needle.



DIBRANCHIATE CEPHALOPODA.

THE PEARLY NAUTILUS, CUTTLE-FISH, AND THEIR ALLIES.

BY HENRY WOODWARD, F.G.S., F.Z.S., ETC.,

Of the British Museum.

PART II., WITH PLATES III. AND IV.

(*Continued from page* 14).

In the first part of this paper I gave a brief account of the four-gilled (Tetrabranchiate) division of the Cephalopods.

I propose now to speak of the second great section, the Dibranchiate, or two-gilled Cuttle-fishes.

This division includes the most active members of the *Cephalopoda*. They are nearly all oceanic free-booters, owning no country and scarcely frequenting any shore.

They have (with one exception—the Argonaut) a thin internal shell, often quite rudimentary, eight or ten arms, provided with suckers, and in the fossil genera, from the Oxford Clay and Lias, provided with numerous hooklets.

Professor Owen was really the first to establish the existence of this second order of Cephalopods breathing by two gills.

The characters which co-exist with the two gills are the internal rudimentary shell, and the substitution of other means of escape and defence than those which an external shell would have afforded, viz., powerful arms, furnished with suckers and the secretion of an inky fluid, with which to cloud the water and conceal their retreat; more perfect organs of vision, and superadded branchial hearts which render the circulation more vigorous.

A few which have no fins have a webbed parachute spread between the arms, by the rapid contraction and expansion of which they aid in their retreat. (Plate III., Fig. 8.)

The use of sepia-ink for writing is of most ancient date, being mentioned by Cicero.

"Indian-ink" was supposed to be all made from the ink-bags of Calamaries, etc., but it is now known to be made from vegetable products, etc. It is constantly met with in the Lias and Oxford Clay in the fossil state, and appears to be perfectly indestructible. (Plate III., Fig. 6.)

Dr. Buckland is recorded to have passed some off on an artist friend, who praised its quality exceedingly.

The animals of this division all possess the power to vary the colour of their skin. This is effected by means of variously-coloured pigment-cells, in *Sepia*, black and brown; in *Loligo*, yellow, red, and brown; and in the Argonaut and some Octopods there are blue cells besides. By the alternate contraction or expansion of these cells, the colouring matter is condensed or dispersed at the control of the animal, so as to change the colour like the Chameleon.

The Cuttle-fishes are nocturnal and crepuscular in their habits, concealing themselves during the day or retiring to deeper water.

It is difficult to estimate the size such creatures may attain.

A dead Cuttle-fish, found floating out in the Atlantic, by Quoy and Gaimard, weighed more than two hundred pounds. Banks and Solander mention one six feet long, seen by them in the Pacific Ocean.

The difference in the size of the species in the *Nautilus pompilius*, *macrocephalus* and *umbilicatus*, may be due to sex, as it is considered the male differs but little from the female.

In the *Loligos*, *Octopus*, *Sepia*, etc., this is not the case, the *male* being only known in a very few instances. He appears literally to be what an American writer has been pleased to call the ladies in reference to the "Women's Rights Bill," "a mere side-issue in the question." The male has no shell of its own, is very minute, and lives as a parasite upon the female.*

Family 1. The *Argonautidæ*.—The Argonaut (Plate I., Fig. 1) is the most interesting of this group, perhaps because of the legend of its sailing propensities. The shell is thin and translucent, and the animal is not attached by shell-muscles. The animal sits in his boat with his two sail-like *dorsal* arms closely applied to the sides of his shell, and swims only by ejecting water from the funnel, and crawls the reverse way, carrying its shell over its back like a snail.

Aristotle was the originator of the fable of the *Nautilus* floating on the sea in fine weather, and holding up its sail-shaped arms to the breeze; a pretty fable, which poets and bookmakers have continued to repeat ever since.

Four species of Argonaut are known: they inhabit the warmer parts of the open sea throughout the world.

* According to Dr. Müller, the Hectocotyle of the Argonaut is an *arm irregularly metamorphosed*, and spontaneously detached (when the fluid formed in the true testis has been deposited in it), enjoying an independent life, feeding on the female Argonaut, and fecundating by a true union.

One species is fossil in Piedmont.

Family 2. *Octopodidæ*.—The Octopods are solitary eight-armed shell-less * Cuttle-fish: they have a web uniting their arms at the base. They frequent the rocky pools of all shores in temperate and tropical zones, they are very active and voracious. (See Plate III., Fig. 9).

Dr. Darwin writes concerning them in his "Journal of a Naturalist in a Voyage round the World"—"Although common (at St. Jago) in the pools of water left by the retiring tide, they are not very easily caught. By means of their long arms and suckers they can drag their bodies into very narrow crevices, and when thus fixed, it requires great force to remove them. At other times they dart tail first with the rapidity of an arrow, from one side of the pool to the other, at the same instant discolouring the water with a dark chesnut-brown ink. They also escape detection by varying their tints, according to the nature of the ground over which they pass. In the dark they are slightly phosphorescent."

Forty-six species (divided into six genera) have been described belonging to the "Poulpe" family.

The formidable nature of this creature has been romantically described by Victor Hugo in his "Toilers in the Sea," and by many other writers.

In Family 3, are placed the "Calamaries," or "Squids" (*Teuthidæ*). In the two preceding families (the *Argonautidæ* and *Octopodidæ*) the animal was characterised by having eight arms; in the *Decapoda* to which the *Teuthidæ* and *Belemnitidæ* belong, the animal has eight arms, and a pair of more or less elongated tentacles, serving as two additional arms (Plate III.).

1.—*Loligo*, the first genus, occurs from three inches to three feet in length. They are all good swimmers, and the shell (which is internal) resembles a transparent quill pen (Plate III., Fig. 4, and Plate IV., Fig. 4).

The calamaries are not only good swimmers, but they can also crawl head downwards on their oral disk.

The common species is used for bait by fishermen on the Cornish coast.

They are cooked and eaten by the Spanish as a delicacy. Their egg-clusters have been found to contain nearly 40,000 eggs.

A form of *Loligo*, found on the coast of Greenland, has been

* Although spoken of here as "shell-less," there are two short styles enclosed in the substance of the mantle which Professor Owen considers are the representatives of the shell.

described by Dr. J. E. Gray under the name of *Gonatus*. It has one species, the *Gonatus amœna* of Müller.

Twenty-one species of *Loligo* occur from Norway to New Zealand. Some of the species are gregarious and so abundant in the Southern Ocean as to afford the principal food of the sperm whale.

One test by which the "spermaceti" of commerce is known to be genuine, is the presence of the beaks of the *Loligo*, which are found sticking in it.

2.—The *Sepioteuthis* has thirteen species, almost as widely distributed as *Loligo*, with which it is equal in size, attaining three feet in length.

3.—*Cranchia*, a small genus, has two species; common to the west coast of Africa.

4.—*Sepiola* (two to four inches in length) has six species; found on the shores of Britain, Norway, Japan, etc.

5.—*Rossia* (three to five inches in length) has six species; inhabiting Arctic Seas, Britain, etc.

6.—*Loligopsis* (six to twelve inches in length) has eight species; common to the Atlantic, etc.

7.—*Cheiroteuthis* (body two inches, arms eight inches, tentacles three feet long!). Of this remarkable form there are only two species; inhabiting the Gulf-weed in the Atlantic, it has also been taken in the Mediterranean Sea.

8.—*Histioteuthis* (sixteen inches in length) has two species; met with in the Mediterranean.

9.—*Onchyoteuthis*, or "the Unicarinated Calamary," varies in length from four inches to two feet. It is solitary, not gregarious in habit like the other genera. It frequents the Sargasso Sea and the Indian Ocean. Its tentacles are armed with hooks like many of the fossil genera. Six species have been described by naturalists.

10.—*Enoploteuthis*, or "the armed Calamary," has likewise a double series of horny hooks upon its arms.

The body, exclusive of the tentacles, measures two inches to one foot in length, the arms are sometimes six feet long! The Polynesian Islanders, who dive for shell-fish, have a well-founded dread of this formidable monster. Ten species are known, from the Mediterranean and the Pacific.

11.—*Ommastrephes*, the "Sagittated Calamary" (Plate III., Fig. 7) is from one inch to four feet in length.

It is gregarious in its habits, and frequents the open sea in all climates.

It forms the principal food of the Dolphins, Narwhale, Cachalots (sperm-whales), as well as of the Albatross and larger Petrels.

Dr. Mörch mentions, in a letter to the late Dr. S. P. Woodward, that according to an old Icelandic chronicle a "sea-spectre" (an *Ommastrephes*) was driven ashore in 1639 as long and big as a man; it had seven tails, upwards of two yards long (the eighth was very likely lost), and one very long tail (one of the two tentacles—the other being lost) four to five fathoms long. The tails were crowded with buttons, like eyes, with a pupil and eyelid, which were gilt. This evidently refers to the *suckers*.

Gould gives the following interesting description of the Sagittated Calamary. "Their usual mode of swimming is by dilating their sac-shaped body and filling it with water. The body is then suddenly contracted, and the water forcibly ejected, so as to propel them backwards with great rapidity. So swift and straight is their progress that they look like arrows shooting through the water. Whenever they strike the shore, they commence pumping the water with increased violence, while every effort only tends to throw them still further upon the sands, until they are left high and dry. The body is beautifully spotted with colours, which seem to vary with the emotions of the animal. At one moment they are a vivid red; at the next a deep blue, violet, brown, or orange. They devour immense numbers of small fish, and it is amusing to watch their movements, and see how, at a distance of several feet, they will poise themselves, and in an instant, with the rapidity of lightning, the prey is seized in their long arms and instantaneously swallowed. They, in their turn, are devoured by the larger fishes, and are extensively used for bait in the Cod-fishery" (p. 318).

Mr. Whiteaves, the Honorary Secretary of the Natural History Society, Montreal, told the writer that, at St. John's, Newfoundland, where the Cod-fishery is very extensively carried on, and, indeed, all along the coast, a shoal of "Cuttles," or "squids" is as great a benefit as a shoal of Mackerel, or even more so, *for bait* for the Cod-lines.

The sailors long ago christened them "sea-arrows," or "flying-squids," from their habit of leaping out of the water, often to such a height as to fall upon the decks of passing vessels. They leave their eggs in long clusters floating at the surface of the open sea.

There are fourteen recent species, and four forms of fossil-pens from the Upper White Jura of Solenhofen have been attributed to this genus.

Of the other remains of Calamaries in a fossil state, we have the following genera :—

12.—*Teudopsis* (having a pen like *Loligo*), there are five species, occurring in the Upper Lias of France and Germany.

13.—*Beloteuthis*, with six species, from the Upper Lias of Wurtemberg.

14.—*Geoteuthis*, with nine species, occurring in the Oxford Clay, Chippenham, the Upper Lias of Calvados and Wurtemberg, and the Lower Lias of Lyme Regis.

Besides the pens, this Calamary exhibits in the fossil state the ink-bag, the muscular mantle, and the bases of the arms; these are from the Oxford Clay, and were obtained by that able collector, the late William Buy, of Chippenham.

Some of the ink-bags found in the Lias, are nearly a foot in length, and are associated with the brilliant nacreous layer of the delicate shell indicating a Calamary of gigantic size. It is difficult to imagine how the sepia was so well preserved, as the recent Calamaries "spill their ink" on the slightest alarm.

We have then one hundred and twenty-three species of Calamaries, twenty-four of which occur in the fossil state.

The second division of *Dibranchiate Cephalapoda* includes :—

1.—The *Belemnites* (Plate III., Fig. 6, and Plate IV., Fig. 1), of which more than 100 species occur fossil from the Lias to the Gault; whilst five species of a second genus,

2.—(*Belemnitella*) carry on the group to the U. Greensand and Chalk.

The guard is the part usually found; but in *B. Pratti* the phragmacone can also be seen, which consists of a series of small chambers fitting into the guard, whilst the *pen* is represented by two nacreous bands on the dorsal side of the phragmacone, and rising beyond its rim, in the form of two sword-shaped processes. The guard is compact and fibrous.

A remarkably perfect specimen of *Belemnites Bruguierianus*, from the Lias of Lyme Regis, was figured and described by Professor Huxley in 1865, in the "Memoirs of the Geological Survey," which exhibits the guard, the phragmacone, the pro-ostracum, the beaks, the acetabular hooks with which the arms were furnished, and the ink-bag.

The specimen has lately been acquired for the British Museum.

The phragmacone usually owes its preservation to being infiltrated with carbonate of lime. The meniscus-shaped casts of the

chambers, often occur, like watch-glasses, piled loosely upon one another.

The common people call the guards of the Chalk, *Belemnitella* "Thunderbolts"!

The genus, *Acanthoteuthis*, is probably synonymous with *Belemnoteuthis*. It is founded upon the fossil hooks of a Calamary, preserved in the Solenhofen Limestone, Bavaria.

3.—*Belemnoteuthis* (the fossil Calamary of Chippenham) is so well-preserved as to show the thin fibrous guard (Plate IV. Fig. 3), the phragmacone, the arms and tentacles covered with hooklets, the ink-bag, funnel, eyes, etc. A wonderfully perfect example of this may be seen in the British Museum.

4.—*Conoteuthis* occurs fossil in the Neocomian of France. This shell connects the ordinary Calamaries with the Belemnites.

5.—The *Sepia*, or Cuttle-fish (Plate III., Fig. 5, and Plate IV., Fig. 2), forms one of the fifth family of Dibranchiate Cephalopods.

The Cuttle-fish lives in-shore; the shell is oval in form and internal, very thick in front and concave internally behind, and terminates in a prominent *mucro*, or spine. The thickened part is composed of numerous plates, separated by vertical fibres, which render it very light and porous. (Plate IV., Fig. 2.)

Cuttle-fish bone was formerly employed in medicine as an antacid by apothecaries; it is now only used as "pounce" by lawyers, or in casting counterfeits.

The bone of one species of Chinese Cuttle-fish attains a length of one foot and a half. The animal is largely used for food in Spain, and also in China and Japan.

There are thirty species, and their distribution is cosmopolitan.

6.—*Belosepion sepioidea*, from the London Clay, is nearly allied to *Sepia*.

7.—*Beloptera*, another Eocene form, is only known from the mucro. It occurs in France, and also at Bracklesham.

8.—*Belemnosis*, a third Eocene form, found at Highgate, has the mucro chambered and siphuncled.

9.—*Spirulirostra* (Plate I., Fig. 3) has also a chambered mucro, with a *ventral* siphuncle.

If the guard were knocked off this pretty Miocene shell from Turin, we should have a form closely resembling the shell of the living *Spirula*.

10.—The sixth and last family contains the solitary genus *Spirula*. (Plate I., Fig. 2, and Plate IV., Fig. 5.)

Only one entire specimen has ever been obtained of this beautiful little Cephalopod, on the coast of New Zealand. So abundant is it, however, that its delicate shells are wafted by the Great Pacific Current to the Cape, thence across the Atlantic to the Gulf of Mexico, and again by the Gulf Stream to the shores of Devon and Cornwall.

The shell is internal, and wholly composed of pearl. It is placed in the reverse position in the body of the animal to the other involuted shells. The last chamber is said to contain the ink-bag. (Plate IV., Fig. 5.)

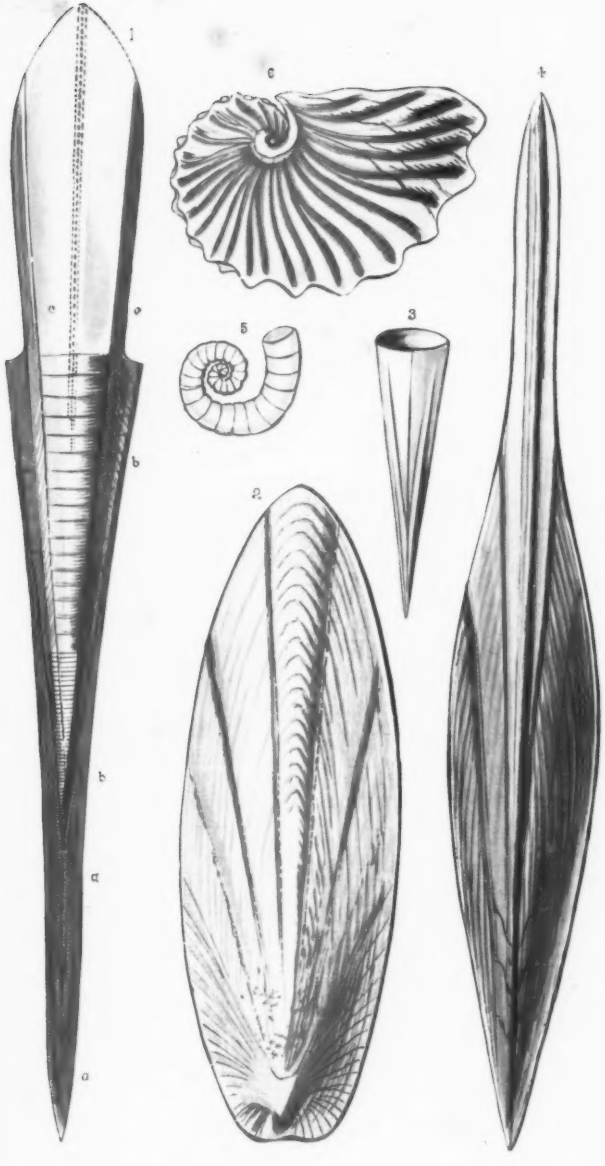
In this division we have 205 species, by far the larger proportion of which are fossil forms (172 fossil, 33 living).

The distribution in time and space which the *Cephalopoda* claim, the unmatched symmetry and wondrous architecture of their pearly shells, the concentration of their nervous system, and their general high development, render them, as a group, specially deserving of study, and whether we examine the successive modifications which the group has undergone in the long series of geological epochs since palæozoic times through which it has passed, or go down, like the naturalist Pliny did of old, to the sea-shore, and study their living hosts, we cannot fail to find matter for most interesting research and inquiry.

Even the geometrician may find, in the form and variation of the shells of this group, an object for study without a parallel in any other class; whilst, to the Darwinian, a wonderful problem is presented for solution, for which ample materials are furnished, from the earliest rocks and the seas of to-day.

Explanation of Plate III.

Fig. 1. Magnified drawing of part of the Lingual teeth of *Octopus vulgaris*. Vigo Bay.
Fig. 2. Eggs of *Sepia officinalis*, Linnæus. Britain.
Fig. 3. Jaws of *Loligo vulgaris*, Lamarck. Ditto.
Fig. 4. Arms, tentacles, and oral disk of *Loligo vulgaris*, (*a*, *a*, *a*), arms; (*t*, *t*), tentacles; (*f*), funnel.
Fig. 5. *Sepia officinalis*, Linn. British.
Fig. 6. Belemnite (restored), showing (*g*), guard; (*p*), the phragmacone; and in the cavity above it the ink-bag.
Fig. 7. *Ommastrephes sagittata*, Lamk. Coast of Newfoundland.



DIBRANCHIATE CEPHALOPODA, RECENT AND FOSSIL.

Fig. 8. *Eledone moschata.* Mediterranean. (This species emits a musky smell when irritated.)

Fig. 9. *Octopus horridus,* D'Orb. Mediterranean.

With the exception of Figs. 1 (which is magnified) and 3 (which is about half the natural size), all the figures upon this plate are greatly reduced.

Explanation of Plate IV.

Fig. 1. Shell of *Belemnites Puzosianus,* D'Orb. Oxford Clay, Chippenham. One-third natural size. (*a, a*), the guard; (*b, b*), the phragmacone; (*c, c*), the nacreous pro-ostracum.

Fig. 2. Internal shell of *Sepia officinalis.* Half natural size. Recent, British.

Fig. 3. Guard (?) of *Belemnoteuthis antiquus.* Half natural size. Oxford Clay, Chippenham.

Fig. 4. Internal pen of Calamary, *Loligo vulgaris.* Half natural size.

Fig. 5. Internal chambered pearly shell of *Spirula lævis,* Gray. New Zealand. Natural size.

Fig. 6. Shell of *Argonauta hians,* Solander. China. One-third natural size.

The writer of this article is largely indebted to the notes of his late brother, Dr. S. P. Woodward, F.G.S., for many of the facts, etc., contained in this and the preceding paper.

THE OLDEST HUMAN REMAINS IN EUROPE.

BY P. MARTIN DUNCAN, M.B. LOND., F.R.S.,

Secretary of the Geological Society.

THE questions of the origin and primitive condition of the human race, are gradually assuming such great importance, that it is absolutely necessary to reconsider the value of the evidence which has been published in support of the high antiquity of certain portions of the skeletons of men found in sediments. Not many years since it was a favourite dogma that human bones could not be preserved for any long period without decomposition taking place, and that they were therefore not liable to become fossilized. But year after year there has appeared some evidence in opposition to this theory, and now there are many specimens of human bones which have been dug up from sediments whose positions indicate a very considerably antiquity. Some of the specimens were obtained during the careful and scientific excavation of caverns by qualified geologists, and others were discovered under less satisfactory circumstances. There has been great doubt expressed about the discovery of some of the human remains, and much suspicion exists about others. Their extreme rarity, and the facilities for deception, have been advanced as arguments against the fact of any human bones having been really found in positions where they must have remained undisturbed during great changes in the physical geography of the neighbourhood. Moreover, the indisposition to concede a high antiquity to man has tended to the rejection of trustworthy evidence to the contrary.

There has always been a great disinclination to associate man with the extinct mammalia. He was supposed to belong essentially to the existing state of things. Moreover, there has been a strong objection to the possibility of great physico-geographical changes having occurred during the human period. But now that palæontology and natural history have combined to prove the vast antiquity of many existing species of animals, there is no reason, if the book of nature is alone studied, why man should not have a corresponding age. The antiquity is of course measured by certain geological changes in continents, and alterations in the relative positions of sediments, rivers, and seas.

Opinions overcame many facts in the early part of this century, and every discovery of human remains in association with the extinct fauna was discredited. It had occurred over and over again that

huge reptilian bones, or those of the mammoth and whale had been ignorantly decided to be those of giants. These mistakes, coupled with the dogma about the impossibility of the preservation of human bones, affected the judgment of some very distinguished men. Of late years the speculations of some biologists respecting the simian characteristics of certain portions of the human crania that were found in very old deposits, have made the subject of the antiquity of man very distasteful and unpopular. But from an early date in this century, well authenticated instances of the discovery of human bones in association with the remains of the extinct fauna have been carefully detailed in many first class scientific journals. The late Dr. Buckland, although an enthusiastic geologist, appears to have been influenced by the opinions concerning the impossibility of the preservation of human bones in deposits for any very long period. Those who are acquainted with the general characteristics of very early burials, and who have read Lartet's description of the caves in the valley of the Vezère, must be struck by Buckland's very off-hand determination of the age of the so-called red lady of Paviland. During some excavations in the Goat's-hole cave, fifteen miles west of Swansea, Dr. Buckland came upon traces of human remains in close contiguity with the skull of a mammoth. The left side of a human skeleton was found surrounded by red earth, and stained of the same colour; it had some small ivory rods close to it and some common shells of the sea shore also. Six inches of earth covered the skeleton, which was in the same kind of soil as and on the same level with the head of the mammoth. This huge cranium was covered with a much greater depth of soil, but was further from the opening of the cave than the human remains. Dr. Buckland pronounced these to be comparatively speaking modern as regards the date of their sepulture, and to have no relation to the mammoth's head as regards their deposition. He was of opinion that the bone earth of the cave had often been disturbed by excavators, and that the skeleton was that of a woman who had died long after the sediment had been deposited. Dr. Falconer took Dr. Buckland's view of the age of the red lady, and drew attention to the similarity of the ivory rods to those which were common on both sides of the English channel in prehistoric times. Since Dr. Buckland described the cave many have visited it, and there is one important fact upon which all are agreed, and that is that flint instruments of palæolithic age were found on the surface of the remains of the bone earth. The force of the expression that repeated excavations have been made in the cave, is lost when there

are such proofs of the antiquity of the bone earth. No one was likely to bury anything there of late years, for the cave is very difficult of access. That the red lady was buried, there can be little doubt, but it is evident from the nature of the surrounding deposits, and the character of the funeral accessories, that this took place in palæolithic times. The skeleton, or rather what remains of it, is not, however, that of a woman, but of a tall male. It is worthy of the attention of anatomists and is very interesting to antiquaries, for it is the only considerable portion of the human frame found in Great Britain in association with the extinct mammalia.

Aimé Boue, a German geologist of excellent reputation, found some human bones at Lahr under that silt of the Old Rhine which is called the loess. The discovery was neglected, and the matter dropped. Nevertheless the details of the excellent observer were recorded, and have lately been substantiated by a corresponding discovery at Eguisheim, near Colmar. Aimé Boue had not a class of readers that would accept the inferences which must be drawn, respecting time, from the consideration of the position of the remains beneath the loess; and probably there were not half a dozen men in the world that could make up their minds about the age of this deposit. This question will be carefully considered further on.

About this time a human jaw was found near Maestricht, at a depth of nineteen feet from the surface, in a stratum of sandy loam which rested upon gravel.

After Aimé Boue's discovery, the remains of man associated with those of the reindeer, in clay, were found by M. Tournal, in a cave at Bize, near Narbonne. This able anatomist and antiquary grasped the importance of the discovery, and he made the first attempt at a classification of post-tertiary geology. He established a human period—Anthropoienne—and divided it into ante-historic and historic sub-periods. This was in 1828.

In 1833, Schmerling published his "Recherches sur les ossemens Fossiles découvertes dans les Cavernes de la Province de Liége." He described the details of his discovery of the human skull at Engis, and sent the specimen to Paris. The cave in which it was found had been opened under the personal superintendence of Schmerling. The remains were discovered at a depth of a metre and a half underneath an osseous brecchia formed of the remains of small animals, and which contained the tooth of rhinoceros and some of those of the horse, and of ruminants. Remains of rhinoceros, horse, hyæna, and bear, surrounded the skull on every side (*de toute part*). Moreover, from another observation of Schmerling's, it

is evident that the mammoth was associated with the human remains, which he says were *entourés de ceux d'elephant, de rhinoceros, et des carnassiers*. The great Parisian anatomists were as unprepared for the discovery of the association of human remains with those of the extinct mammalia as their fellow savans. Schmerling's labours were discredited, and the great age of the Engis skull was denied, because it presented the closest resemblance to many ordinary and modern crania. It was supposed by the advocates of the progressive development theory, that some alteration in the contour and shape of the bones of the head must have occurred in man during the vast ages that must have elapsed since the mammoth died out in Europe. The Engis skull was too human, and therefore the voice of authority was not heard in its favour. Schmerling was, however, a first-class comparative osteologist, and his work was so carefully compiled from his own notes that it could not be forgotten. He described the different kinds of gravels and clays in which the animal and human remains were found, and divided them into two series. He did not see the geological value of his divisions, for the science was still in the midst of its struggle to get out of the hands of the cataclysmatists. But he distinctly noticed one gravel which was at the bottom of the caves, and whose stones were not of the rock of the nieghbourhood, and a second gravel and clay, whose angular masses were composed of the limestone out of which the rivers and caves were worn or excavated. He noticed that some very ossiferous earth exactly resembled the soil which caps the top of the hills of the neighbourhood. Thirty years elapsed, and Dupont began to describe the caverns of the Lesse, close to the seat of Schmerling's labour. The science of geology had greatly increased in the meantime, and the effects of fluviatile erosion, and the phenomena of making and moving gravel had been particularly studied. If any evidence were required to prove the correctness of Schmerling's work, it has been offered over and over again by Dupont, whose classification of the sediments containing the osseous remains in the caves is simply an extension of the ideas of the great Belgian anatomist.

The soil that capped the hills around Liege, and which Schmerling noticed to be ossiferous, is an extension of that loess under which Aimé Boue had discovered human remains. But this geological fact was not satisfactorily determined when the Neanderthal skull and bones were discovered. Dupont's researches had not shown geologists clearly what the loess was, and, indeed, he had not written on the subject. His elaborate investigations, which form the only

satisfactory ground-work for the study of the antiquity of man in relation to geology, were not before the world when the skull and bones just mentioned were found in a fissure leading from the plateau above the valley of the Neander down into the ravine. The fissure communicated with the cliff face of the valley at whose base flowed the river, and its upper outlet was on the surface of the country, all of which is more or less covered by the loess. This loess filled the fissure, and in it were the bones. The skull was peculiar in shape, and it attracted great attention. Its position in the great deposit of silt or loess which covered the country around the Rhine and its branches and extended far to the east, and which had been worn down by the great river and its affluents until it formed here and there cliffs hundreds of feet in height, indicated extraordinary changes in the physical geography of Europe during and after the time of the early men. Aimé Boue's discovery was not considered, Schmerling was still comparatively unread. The shape of the bones appeared to cause distinguished savans to run riot, and the Neanderthal skull became one of the wonders of the age. Yet, if there could be no doubt thrown upon the deposition of the skull in original and unmoved loess, there is now abundance of evidence to show that its antiquity is greatly inferior to the Engis skull, and to those human remains found by Dupont in some of the caves in the valley of the Lesse. Such remains, for instance, as the lower jaw, found in the cave of La Naulette, and the bones and skulls discovered in the caverns named Du Frontal and La Rosette. But there is every reason for believing that the fissure in the Neanderthal rock was not filled during the deposition of the loess, and that the upper opening and the cavity was closed at that time. If this theory is correct the loess may have drifted down the fissure at any time between its deposition and the historic period or afterwards. The body whose bones were found in the midst of the silt in the fissure may have been washed down, or its possessor may have fallen down during the in-wash of the sediment. The excavation of the valley close by does not appear to be necessarily associated with the deposition of the loess in the fissure. The Neanderthal skull cannot, therefore, be considered of any value as a type of great antiquity. It should be placed after the human remains found by Aimé Boue at Lahr, and by Faudel at Eguisheim in the chronology of man.

M. Faudel has described the position of the human frontal and parietal bones that were found close to the hill called Bühl at Eguisheim near Colmar. ("Ann. des Sciences Nat." v. serie, tom. vi.

p. 361.) There is a cliff formed of an old sandstone deposit, close to Eguisheim, and the hill of Bühl is a slight elevation which rests against it. The hill slopes off into a plain which extends towards Colmar. The under part of the hill is formed by a tertiary limestone which dips towards the plain at an angle of from fifteen to twenty degrees. The upper part is formed of the loess or upper silt of the second glacial extension, and it is thick on the flanks but thin on the top of the hill. At the base of the hill some of the old Alpine gravel of the first extension of the glaciers is found, and it is covered by the loess just mentioned to the extent of two or three metres. Some bones of the stag were found in sinking cellars in the loess in 1865, and shortly afterwards the human remains were exhumed. Some elephantine remains were found in the old gravel, but none were discovered in the true silty loess. The human remains were found in the silty loess, and consisted of a frontal and parietal bone; they were separated, but could be united easily. The loess contained the usual shells of the deposit. *Helix hispida*, Lin.; *Pupa muscorum*, Drap.; *Succinea oblonga*, Drap.

The jaw discovered by Crahey of Louvain, and which is known as the Maestricht jaw was found above the old Alpine gravel and in the lowest part of the loess. The old gravel had been much disturbed and its elephantine fossils had been ploughed up by the torrents that accompanied the formation of the lowest part of the silty loess, consequently there is a great mixture of the faunas of the deposit. The jaw may be fairly considered to be of the same geological age as the remains at Lahr and Eguisheim.

The antiquity of the human remains found in France in the gravels of the Somme and Seine, in the Grotto des Feés, in the caves of Perigord, and in those of the south-eastern part of the country has been the subject of much discussion. Many of the French anthropologists hold to their original opinion that the lower jaw bone discovered in the gravel at Abbeville was not introduced there a short time previously to the visit of the "finder" and that it was deposited with the sediment that surrounded it. They assert that other bones were found there subsequently. A careful examination of the evidence that has been published concerning the Abbeville jaw proves that there is much reason for doubting its antiquity, and when the collateral proof of the successful and abortive attempts at deception respecting many of the flint implements said to have been found in the same gravel as the jaw are considered, there is nothing left but to put the mandible on one side as an untrustworthy piece of humanity. The lower jaw discovered in the Grotto des Feés was

associated with the remains of the extinct mammalia, and a careful examination of the evidence leads to the belief that although the cave had often been disturbed, the bone was not introduced artificially, but was washed in with the remains of mammoth, rhinoceros, and bear. The fact of the cave having been frequented for years before its excavation, renders the artificial introduction of the bone possible, and although such a proceeding was most improbable, the value of the relic to the anatomist and to the student of early man is seriously affected.

M. Reboux found human bones in the gravels of the Seine, and they are known as the Clichi-Montmarte remains. There can be no doubt about their having been found where they are stated to have been met with, but their age is not satisfactorily determined. Considering the evidence brought forward, these bones may be associated with those of the palæolithic age, but not with those of the age of the mammoth.

The skeletons found in the cave at Cro-Magnon, in the valley of the Vezère in Perigord may be taken as the types, as regards age, of the osseous remains discovered in south-western, and southern France, associated with the antiquities of the reindeer period. Bruniquel, Bize, and other caves have yielded portions of human skeletons, but the admirable condition and the extraordinary development of the Cro-Magnon skulls, femora, and tibiæ, offer such opportunities for study and comparison that they necessarily have attracted the greatest attention. The Cro-Magnon skeletons were found on the top of the remains of a shelter or cave which was nearly filled. They belonged to individuals who had been buried, and one had certainly died a violent death. There were no antiquities found above them, and beneath were the relics of the reindeer age. There were several old hearths in the cave one over the other; they were formed of charcoal, charred bones and ashes, and they were separated by masses of limestone which had fallen time after time from the roof. In the lowest of the hearths was part of the tusk of a mammoth. The age of these skeletons cannot be decided by means of any geological data, and it can only be estimated in a very comparative and unsatisfactory manner by considering the antiquities of the other caves of the valley. The discoverer of the bones, M. Lartet, and their describer, M. P. Broca, consider them to belong to the age of the mammoth. To this opinion I cannot defer, and I would rather give them the age of the reindeer in M. Lartet's classification of prehistoric archæology.

In northern Italy there is a great difficulty in deciding the exact

relation of some very old bones to the Alpine silt or loess, which, like that of the rivers to the north of the Alps, covers much of the country.

There is an old and a new Alpine gravel and silt, south of the Alps, just as there is to the north; and the position of the skull discovered at Olmo in these sediments is unsatisfactorily determined. The older sediment consists of the down-wash of the great moraines and glacier mud that followed the retreat of the glaciers when the so-called glacial period of Europe and the north ceased. This sediment, the first Alpine gravel, contains the remains of the great mammalia. The younger silt is the product of the second glacialization of the Alps. It is the wash-down of the moraine mud of the glaciers which extended far into the Italian plains during the period when the great mammalia became comparatively extinct, and the Arctic animals typified by the reindeer, musk sheep, and glutton roamed through Western Europe. This second Alpine gravel may have been formed or rather spread over the plains at any period between the end of the second glacial period and the departure of the Arctic animals from amongst the Western European fauna. Consequently bones covered by it have not the same geological value as those found amongst the older or first gravel. M. Cocchi's description of the discovery leads to the belief that the Olmo skull is like that of the Neanderthal, very likely very old and perhaps comparatively modern. It is reasonable, however, to give a palæolithic date to the Olmo skull.

The age of the human bones discovered by M. Dupont has now to be considered, and it will be observed that by bringing these remains in careful association with the geology of Belgium, a classification of the antiquity of all the human remains noticed can be founded upon very satisfactory reasoning. Europe, north and south of the Alps, in the Alps, and to their east and west, and in and about the Pyrenees, has experienced some grand changes in its physical geography since man first appeared on the western area. The geological phenomena that prove this, show a relative contemporaneity as regards the conditions in the Alps, Pyrenees, Vosges, and Ardennes. There are evidences of two great extensions of the glaciers, and of the former presence of coast lines now either worn away or submerged. What the phenomena of life were on the continent of Europe when the glacial conditions extended to the Thames, when icebergs grounded in the Channel, and when glaciers, hundreds of miles long, descended from the mountainous districts of Europe, no one can imagine. But it is evident that this glacialization was terminated by a general

and very gradual upheaval of the whole of Europe. With increased warmth came huge rivers that spread their gravels and cut their way down as the land rose. These gravels were not formed from the rock subjacent to them, but of materials from a distance. Such a gravel formed of crystalline and gneissic rocks covers much of the elevated land of Belgium, near Liège and Dinant. It is known as the Ardennes gravel; it is water worn and round. It was washed down from the Vosges and Ardennes as their glaciers retreated, and as that part of Belgium became upheaved. This gravel is the geological equivalent of the old Alpine gravel of the Rhine, and of the first gravel of the Italian plains. As the Belgian plains arose they were cut into by the streams, and this gravel was washed down them, and into their caves. At last a period of rest came, and the deep and narrow valleys of the Lesse were still carrying down the mud and stone of the Ardennes gravel. This was the age of the great mammalia, and it is in the mud and gravels of this period that the jaw of the Naulette Cave was found and the Engis skull discovered. The high level gravels of England and of the Somme Valley belong to the earliest part of this period during which Europe was inhabited by not less than four species of elephants.

A gradual depression of the European area succeeded the period of rest. The second extension of the glaciers occurred, and the greater part of the pachyderms and many carnivora became extinct. Again a period of upheaval commenced, and the Belgian valleys were choked up with their own wear and tear—not with the Ardennes gravel which was covered with it. As the land rose and the glaciers retreated, vast floods brought down the moraine and glacial mud, and finding the outlets choked, deposited their silt or loess to the thickness of hundreds of feet. Still the continent arose, and the Rhine began to cut its way through the loess, and the Belgian valleys were nearly emptied of their contents.

This second gravel of the valleys is angular, and consists of the minerals of the carboniferous limestone of their sides. It is covered here and there by the fine silt or loess, and both sediments were formed about the same time. The angular gravel is the lowest member of the loess, and the silt the upper. It is beneath and amongst this upper member that the Neanderthal, the Eguisheim, the Lahr, and the Maestricht remains were found, and thus their remote antiquity disappears.

Amongst the gravel and the silt are found the remains of the reindeer. There were caves which were open after the deposit of the Ardennes gravel, and within them human remains were buried. These have subsequently been covered up with the angular gravel

before it was washed out of the valleys. Such skeletons as those of the cave Du Frontal, Chaleux, and La Rosette are covered with the angular gravel. Consequently their age dates before the filling up of the valleys with the second gravel. The great mammalia had ceased to be prominent members of the fauna when the sepulture of the cave Du Frontal was closed with a dalle. The time that may have elapsed between the sepulture and the filling up of the valleys may have been as great as that which it took to clear them out again and to re-elevate the country. It leads one back far before the formation of the loess, and yet the reindeer was the most prominent member of the fauna. The results of M. Dupont's studies show that palæolithic man lived during the excavation of the valleys and the filling of the caves more or less with Ardennes gravel. The jaw of La Naulette and the Engis skull are the Belgian human remains of this period. The jaw of the Grotto des Feés is also of this age. These are the only examples of human bones that will bear criticism, and which can be referred to the mammoth age. M. Dupont proves that after the excavation of the Belgian valleys, and the deposition of the Ardennes gravel within their caves, men were buried in the cave Du Frontal, and included in the sediments at Chaleux, and in the cave of La Rosette. No traces of the mammoth (except at Chaleux, where a huge bone was found not belonging to a contemporaneous elephant) were discovered with these remains, which belong to the reindeer period. After the sepulture at the cave Du Frontal, the valleys were deepened, a period of rest occurred, and then commenced the formation of the angular gravel and loess already mentioned. The angular gravel must have filled up the narrow valleys to the depth of 70 metres. Then the silty loess was deposited on the plateau. Subsequently, as the country rose, the angular gravel was nearly cleared out the valleys. The remains of the men of the reindeer period are also to be found in the upper silty loess, and the Eguisheim, Maestricht, and Lahr remains are instances. Above the loess no traces of palæolithic man are to be found, but those of the neolithic age abound. In spite of the new readings of Julius Cæsar's words, *bos cervus*, the remains of reindeer are not found amongst the relics of the Allemanni. The Olmo skull is of the same general age as the Eguisheim and Lahr remains, and to this period the skeletons of Cro-Magnon, of Bruniquel, of Bize, and very probably of Paviland may be appended. The age of the Clichi-Montmartre bones is still in doubt, and those discovered in the sepulture of Aurignac were too much disturbed before they were carefully examined, to be considered of any exact antiquarian value.

THE GOLD COINAGE.

A CONSIDERABLE amount of mystification enshrouds the propositions of the Chancellor of the Exchequer as to the gold coinage, and this notwithstanding a protracted controversy thereon in the columns of the daily press. With a view, therefore, to making the whole question more intelligible, we shall furnish some particulars as to the existing gold coins of this country, and offer some comments upon Mr. Lowe's suggested improvements. From the tenor of many of the letters which have appeared in the journals alluded to, it might have been inferred that the Royal Mint is in the habit of receiving gold from such persons as are fortunate enough to possess the valuable material, and of exchanging for it, without cost to the importer, newly-made sovereigns of equal aggregate weight. The Mint regulations really justify this impression, but in practice such an arrangement never takes place. Nearly forty years have elapsed since private importers were dealt with in this way, and the eminent firm of Rothschild and Co. were the last of them. However, the law permitting the private importation of gold to the Mint has not been repealed, and at this moment any individual owning not less than £20,000 worth of standard gold may take it to the Mint and demand its conversion into twenty thousand sovereigns, at the expense of the State.

It is possible that some delay might occur in the completion of the transaction, and thus the interest upon the sum would, *pro tem*, be sacrificed. This constitutes, indeed, the deterring influence, and makes it more convenient for successful gold-diggers and others possessing the precious metal, to negotiate with bullion-dealers, who, in their turn, refine the gold they purchase and sell it to the Bank of England. The market price of standard gold, which is $\frac{11}{12}$ fine and the other $\frac{1}{12}$ alloy, is £3 17s. 9d. per ounce. This is three-halfpence per ounce less than the Mint price, but the Bank is a ready-buyer, at this rate, of any quantity, however small, and pays the money on the satisfactory completion of the assay. The bullion-dealer can well afford to sell the material at this price rather than await the tardy action of the Mint. The Bank reaps a profit which compensates it for the delay, and the Mint receives gold by wholesale rather than retail, which best suits its extensive coining arrangements.

The Bank has further the privilege of controlling the Mint so far as the coining of gold is concerned, and may import bullion at a short notice whenever it pleases, and in such quantities as it sees

fit. The Mint is virtually therefore a manufacturing branch of the Bank, and its presses move or stand still at the beck and call of the "Old Lady." The transactions between the two establishments are usually of a weighty nature, for it is very seldom that the sum required by the Bank is less than one million sterling, and very frequently much more is wanted. The average annual out-turn of sovereigns and half-sovereigns from the Mint has equalled five millions sterling for the last ten or twelve years.

Generally, the last-named institution receives the metal for coinage in the form of ingots, which, it may be stated, weigh each about 200 ounces troy, and are worth something near £800. They are weighed in in what are called "importations" of 100 ingots at a time, and in seasons of pressure, approaching to what is known as incipient "panics," as many as twelve importations have passed through the Mint gates per week.*

It is not essential at present to enter into detail as to the manipulatory processes employed in the conversion of ingots into coin; suffice on this point to say that six ingots, with the requisite quantity of alloy (fine copper), constitute what is technically known as a "melting-house pot," which is worth, in round numbers, £4,800, and that fifty of these pots are frequently melted and cast into coining-bars in one day. The bars are afterwards rolled into ribands, from which the blank or plain sovereigns are cut. These latter are next compressed on their circumferences, annealed in ovens, blanched in diluted sulphuric acid, dried in beechwood sawdust, and stamped and "milled" in the coining presses.

The most interesting and, perhaps, important epoch in the history of a sovereign is that which follows its reception of the image and superscription of Her Majesty, and the imprint of the Royal Arms. To all appearance the coin is ready for delivery to the Bank, but it has to pass first an examination of a critical character, and which is literally the turning point of its destiny. It has to be submitted to weighment in the most delicately-constructed balance which the fingers of man can contrive, and if found by this test to be worth intrinsically (the word is humbly used in presence of Mr. Lowe) more than twenty shillings and one halfpenny, or less than nineteen shillings and eleven pence halfpenny, that individual sovereign will never make its exit from the Mint gates.

The law asserts that every 40lbs. weight troy of standard gold

* The eight coining-presses of the Tower-hill establishment are capable of stamping twelve hundred thousand sovereigns per week, or the same number of pieces of any other denomination.

shall be coined (singularly enough, when one remembers what is the current year of grace) into 1869 sovereigns, each weighing, theoretically at least, 123·2744 grains, and representing exactly that portion of an ounce of standard gold at the Mint price (£3 17*s.* 10½*d.*), which its nominal value indicates, and that is twenty shillings. It is impossible for the Mint to create sovereigns in any quantity of the precise standard weight. Gold, with all its peculiarly excellent characteristics, is not homogenous, and the most perfectly constructed mechanical apparatus cannot make strips of gold yield blank pieces of equal weight with each other. Variations of density cause diversity of weight, and although micrometer measurements may demonstrate a thousand blanks to be of equal size, the balance will detect and record considerable differences above and below the true standard. It is not too much to say, that if the law compelled the Mint to issue only gold coins of the exact weight of 123·2744 grains, the annual expense of the Mint would be quadrupled. Fortunately this extreme nicety is not demanded, and what is called a "remedy" is permitted for "fallibility of workmanship" and the evil of non-homogeneity—if the word may be coined. This remedy or allowance amounts to twelve grains on every one pound troy of sovereigns coined, and therefore to about a quarter of a grain, or one halfpennyworth of gold, on each sovereign above or below the theoretical standard weight.* This arrangement is invaluable to her Majesty's coiners, for it enables them to save ninety per cent. of all newly minted sovereigns from relegation to the melting pots; and it is no loss to the public, who, by a balance of heavy and light pieces, get the true standard weight on large quantities of coin. Our readers will now be prepared for a tabular statement wherein are shown—

THE MINT WEIGHTS AND "REMEDIES" FOR GOLD COIN AS AT PRESENT ARRANGED.

Denomination.	Standard Weight.	Legal Remedy.	Legal Maximum Weight.	Legal Minimum Weight.
	Grns. Pts.	Grns. Pts.	Grns. Pts.	Grns. Pts.
Sovereign.....	123·274	0·256	123·531	123·017
Half Sovereign	61·637	0·128	61·765	61·508

Practically, therefore, as has been shown with regard to the

* The remedy allowed by law in respect of coinage is twenty-four grains per one pound troy, or double that of the allowance of gold.

existing gold coinage, intrinsic and nominal value go hand in hand.

The precise value of the sovereign and half-sovereign is known and recognized everywhere. To impair the weight would be to lessen the value of the coins, and to interfere with international and home traffic—as it seems to us—most injuriously.

The Chancellor of the Exchequer proposes to cause each 40lbs. weight of standard gold intrusted to the Mint for coinage to be cut not into 1869, but 1884 sovereigns and a fraction, and then assumes that each coin would pass current at an equal rate of value with that of its full weighted predecessor! It is questionable whether any regulations, however stringently enforced, would confer an artificial value on the Lowe coin in our own country. Abroad, no amount of moral suasion would produce the effect desired. Not even a West African dealer in palm oil and elephants' tusks would be willing to give twenty shillings' worth of goods for nineteen shillings and tenpence worth of gold, although the latter bore the imperial stamp upon its face. By the removal of one grain of gold from the sovereign the piece would become a token, like a silver coin. At present, one thousand sovereigns, if cast into a bar of standard gold, would still be worth one thousand pounds. Let a thousand grains, at twopence per grain, be taken from each coin in a thousand, and what would a bar cast from the mass be worth? The truth is, that if you once destroy confidence in the purity or standard of fineness of the sovereign, or lessen its weight, anarchy would inevitably take the place of order. In addition to this most serious consideration, there must be taken into account the fact that the process of deterioration commences with the gold currency as soon as it passes from the Bank of England. When a sovereign leaves that palace and mixes with the people, degeneration surely follows from the contact. Abrasion and attrition commence their baleful work at once. The sharpness of the engraving on the coin disappears first, and with it some portion of its weight. The eye of the law is upon the failing sovereign, and bankers' balances reveal the growing weakness of his constitution. At a certain stage of declension his circulation may be stopped altogether. And here it may be stated that all sovereigns, as at present in use, may be refused as legal tenders when they have lost in weight $\frac{3}{4}$ of a grain individually. That is to say, that no one can be compelled to receive a sovereign in payment when it weighs less than 122·500 grains, or a half-sovereign when it has declined in weight below 61·125 grains.

Mr. Lowe's new coins would be subject to the same destructive laws as the old coins, with this difference, that when they commence their career, they are actually worth less than the used-up coins of the old stamp.

There are many other questions of moment connected with the gold coinage and its proposed modification, but space at present forbids their discussion, and perhaps enough has been already said to induce the minister to desist from attempting to realize his project.

ESTIMATES OF PROBABILITY.

THERE are few subjects more liable to popular misapprehension than those which involve calculations of chance, and even philosophers and mathematicians are not without their share of error in the application of the doctrines of probability to what are supposed to be chance events. M. Chasles, for example, turned the doctrines of probability upside-down when he considered the genuineness of the forged documents he purchased with such credulous avidity to be manifested by their quantity and variety. He found a man who pretended to have access to, and to be able to sell, twenty thousand, and more, autographs of distinguished persons, from the days of the apostles down to those of Newton, Pascal, Galileo, etc. This "Palæographic Archivist" could, with equal facility, produce letters of philosophers, poets, sovereigns, etc., etc., and the distinguished mathematician he duped looked only to one way—and that a wrong one—in which the doctrines of probability could be applied. He thought it highly improbable that any one man should have made, or be in possession of such a mass of forged manuscripts, executed with considerable skill. If we put the question, is it likely that one "Palæographic Archivist," whom, for shortness, we will call P.A., has *plausibly* forged numerous and complicated letters of Newton and Galileo? we should be inclined to say no; and it is less and less probable that he should have succeeded in making *plausible* forgeries of the writings of apostles, monarchs, poets, etc., in addition to those of philosophers. But the forgeries which imposed upon M. Chasles only seemed plausible while they were unexamined, and it is obvious that if any one took to forging manuscripts as a trade no quantity of work could, in the slightest degree, be evidence of genuineness, though it might establish the fact of

several persons conspiring to commit the fraud. It would require profound knowledge of the history of science, and of the biography of Newton, Pascal, etc., to make a series of forgeries of their writings that would deceive or puzzle persons well acquainted with these subjects; and it would be extremely unlikely that a man possessing enough knowledge of this description joined to the mechanical and moral aptitudes for forgery should also be sufficiently well acquainted with the historical, biographical, and other incidents necessary to enable him to forge equally well letters of Roman emperors, Christian apostles, and distinguished literary men. M. Chasles, without any evidence tending that way, and with much on the other side, imagined that the documents he brought would appear genuine to the various sets of persons whose special knowledge qualified them to judge. He guessed, and guessed wrongly, the data upon which his calculations of probability were made.

If he had considered with what difficulty and at what cost a few hundred manuscripts of early date, or of particular persons, are brought together by experienced collectors, he would at once have been struck with the enormous improbability that any one man should have achieved a success in autograph collecting far surpassiug anything that had been accomplished by a multiplicity of ardent seekers after such treasures all the world over and for many generations.

Perhaps, while M. Chasles did not make good use of the doctrines of probability, his deceiver may have applied them in a somewhat rude and uncomplimentary fashion; and he may have selected a mathematician in preference to another kind of philosopher upon the belief that mathematicians are, on the whole, more credulous than chemists or physicists of equal eminence—a theory capable of some historical evidence, if not of proof; though, perhaps, the real truth lies in the statement that persons devoted to special abstract pursuits frequently have weak faculties of judgment in concrete affairs.

When evidence of a strong kind was brought to M. Chasles that certain of his manuscripts and acquisitions were copied from books written by other persons than those purporting to have made the autographs, he still thought it more probable that the books were copied from the manuscripts, than that his friend, the P.A.'s collection, should be fictitious. Here again he did not apply the probability doctrines wisely.

There might have been a strong, nay, an enormous, *a priori*

improbability that any one man should have made or possessed such a peculiar mass of forgeries; but the moment any part of his collection looked suspicious, the probable character of the lot was affected, and its quantity should have had no weight, except in estimating the number of accomplices likely to have been engaged in the task, or the number of years it would have taken one, or a few persons, to complete it. The only evidences of genuineness were, a versimilitude—experimentally found insufficient, in the cases tried, to deceive experts—and the veracity of the seller.

Now, as soon as the quality of evidence given by one or more persons is doubtful, the *quantity* adds nothing to its probable force, nay, may act the other way, by suggesting collusion, or prevalent error. There are districts in which witchcraft is still believed in, but if one hundred persons all declared they had seen an old woman ride through the air on a broomstick, no more credence would be given to the story than if it were told by fifty or by one. When a witness testifies to a thing highly improbable, there are two things to consider in estimating the value of his statements. His good faith, if ascertainable, settles in his favour the question of deception; and then comes that of his competence to observe accurately and avoid sources of error. Two *independent* witnesses add to the force of concurrent testimony, three still more, and so on, multiplying the probabilities of their correctness; but witnesses labouring under a common defect or delusion, are not independent, and so far as their testimony is the result of that defect or delusion, its quantity adds nothing to the probability that what they say is correct, but on the contrary, tends to show that it is not. Certain persons cannot tell green from red when both are together, and if they see a red light are most likely to call it green. Suppose fifty such persons all state that on a particular night they saw a green meteor in the sky. Their concurrent testimony establishes the fact that a meteor was seen, while their concurrent aberration indicates that it was not as they say, *green*, but red.

If a hundred persons believing in fairy superstitions depose that the fairies have made a ring in a particular field, their testimony is not of *positive* value as to the action of fairies, but *negative*, inasmuch as when their aberration is allowed for, we know that their statement points to a particular fungoid growth, a sufficient cause for the rings, and one that excludes, on account of its sufficiency, fairy agency. Whenever witnesses, old or new, give testimony, subject to a known or probable deviation from truth, the calculator of probabilities is not entitled to multiply it together, and say, here is an

overwhelming probability of their being right, though he may, treating it as negative evidence, multiply it, and say here is an overwhelming probability of their being wrong. If he knew the special kind of distortion to which their evidence was subject, he would be justified in assuming that when they testified to one thing, another and different thing took place. Suppose, for example, there was a community in which epilepsy was believed to be the result of demoniacal possession, and A, B, C, and D, all stated that the devil had been very active in their locality, the probability they would establish is that epilepsy had been rife. And as soon as the sufficient cause of the symptoms, epilepsy, was shown to exist, the imaginary demoniacal cause would be ousted from the field. Thus their testimony, when its aberrations were corrected, would be *positive* for a fact to which they had not deposed, and which they did not appreciate, epilepsy; while it would be *negative* against that which they did believe, demoniacal agency. So, if a number of uninstructed persons say that a shower of blood fell on such a town, we do not believe in the sanguineous character of the incident any more if a thousand affirm it than if only one mentions it. We inquire into the facts, and see whether it is most likely the red drops came from the vegetable or the insect world.

The application of a calculus of probability to historical events, or to recent evidence, is necessarily incomplete and misleading if the probabilities of individual or epidemic error are overlooked. A number of witnesses may be perfectly "independent," so far as the absence of any common motive or intention to deceive is concerned, and yet all may be subject to the same strong and erroneous bias. When the investigation of a particular phenomenon presents peculiar difficulties, the probability of any statement concerning it may not be at all increased by the number of the persons who say the same thing. Take, for example, any of the the recurring tales of wonderful fasting girls, or nuns miraculously imprinted with crucifixion marks, and so forth. No amount of testimony to the non-natural or abnormal character of the alleged incidents is worth anything, except it can be shown that the persons giving the evidence took proper measures to verify their conclusions.

That any number of persons prone to deception should all be deceived by a clever fraud, or by a statement or appearance coinciding with their superstitions or prejudices, is exactly what the laws of probability would lead us to expect; and when delusion or deception of such a nature has occurred, the number of persons who give mistaken evidence adds nothing to its probable force; it only

shows that the bias towards a particular form of unreason was very prevalent in a particular circle.

Amongst the most common popular errors connected with probabilities is that of supposing that when an improbable event has happened the chances are necessarily less that it will immediately happen again. Thus, suppose the chances were twenty to one against a person drawing a black ball from a bag containing both black and white, and yet it happened nine times in succession. If each time the black ball, which was withdrawn; was replaced, and the general contents of the bag in the original condition, the chances would remain twenty to one after each trial. The popular opinion would be apt to consider that as at the beginning it was very improbable that nine black balls should be drawn in succession, and still more so that ten should be so drawn; that *after* nine *had been* drawn, the improbability of drawing the tenth was extremely great, whereas, under the conditions specified, it would still remain twenty to one. Possibly, if the *whole* conditions of such an experiment were known, the probability of the person who had drawn nine blacks drawing the tenth might be *greater* than twenty to one. There might, for example, be a tendency, from mechanical causes, for black balls to come nearer the surface when the whole were shaken together and a particular experimenter might have a habit of taking surface balls.

In tossing with a shilling the chances of "head or tail" are assumed to be equal, and if that is the case the man who happened to get heads ten times running would have an equal chance of obtaining a head the tenth time, and no more. Popular opinion would probably say that the tenth chance was much smaller than one-and-one or half-and-half, and might try to sustain the notion by reference to the original improbability of such an event as ten heads coming in succession. The mathematician would contend that the chances of any one toss were quite *unaffected* by the result of previous tosses, and he would be quite right in the *statement*, though he might be wrong in the use made of it. Clearly, toss 2 could not be *affected* by toss 1, nor could toss 9 by all its predecessors, but the fact of nine tosses turning out alike might indicate either a tendency to a particular mode of tossing or a peculiarity of the thing tossed, and in this case the mathematician would go astray if he ignored this new probability in his calculations.

A sailor's application of probabilities to artillery practice is well known in the maxim that "if a ball makes a hole in a ship put

your head in it to be safe." The truth of this theory is often denied by mathematicians. Let us examine the case. The sailor assumes that a subsequent shot is not likely to hit a place already struck, and the mathematician assumes that the whole or a given portion of the ship, including the spot that has been struck, is equally liable to be hit each time. According to the latter view of the probabilities, A, B, C, D, E, F, may represent portions of a ship's side, which have equal chances of being struck, and if A or F happens to be struck, it still retains exactly the original liability to be hit again. If the sailor, who demurs to this proposition, put his argument into a logical form it might stand thus: He would say, as the result of his experience, that if a ship was struck twenty times the probabilities were that the balls would be distributed over a given area of maximum liability, and that they would average so many inches or feet from a given centre. Suppose it could be shown that there was an average tendency to receive equal numbers above or below a particular line, the probable expectation of the *above* hits would not be diminished by two or three, or four in succession, out of the 20 happening to hit below, and if we assume that the average *variety* of hits is likely to occur, the fact of a hit happening in one place may indicate an improbability that a second out of a given number will occur on that identical spot. Let us suppose that the hit was the result of skill in careful loading and careful aiming. Before the hit took place the calculation of probability might be founded upon a knowledge of the part of the vessel likely to be aimed at, or actually known to be aimed at, and upon the result of previous trials, showing that a given proportion of the balls might be expected to strike within certain limits. All that probability doctrines could do for any one guessing the result would be to suggest that the ball was likely to be somewhere in the most probable area. After the ball had struck would come a fresh question of probability in the following form:—Is it likely that all the incidents of the next loading, aiming, and firing will be exactly the same, or exactly equivalent to those of the preceding shot? If the probability is against this, then the sailor is right; if in its favour he is wrong; while if, for want of sufficient knowledge, no probability either way can be calculated, the matter must be left to open guess.

In fixing the size of a bull's-eye at a given distance, due regard is had to difficulty and skill. A good shot may be much more likely to hit somewhere within the bull's-eye than to miss it, but as in any number of hits an average deviation from each other and from the centre may be expected, the moment any other place

is hit, a probability, varying according to the circumstances, may be established that that particular place will not be hit the next time. Let us presume it ascertained that ten out of twelve balls fired in a particular way will strike within four inches of a given centre. In the absence of information, it may be assumed that each point in the given area is equally liable to be hit; and if that assumption were correct, and the area was divided into twenty spaces, the chances of each would be equal for a twentieth shot, even if one should happen to be hit nineteen times in succession. In point of fact, however, the chances are not equal at each discharge. There are determining circumstances which operate, though unknown, and when one spot has been hit, it is more or less unlikely, according to the distance, the state of the air, and other conditions, that it will be hit again, because hitting it again might require an improbably-close agreement or compensation of the co-operating causes. How far these limitations should be regarded must depend upon the average results of the trials upon which the probability calculation must be made.

In every circle individuals can be indicated who have much more than their calculated share of good or ill luck in chance games, and this deviation from the average fortune attends them for years. Upon pure mathematical grounds it would be assumed that their chances were only equal to those of ordinary folks, and yet shall we blame those who object to place unlucky men in positions where there is a chance that they may fail?

A common abuse of probability-estimates is found in assuming that a thing happens from one particular cause, because no other cause can be predicated with certainty. Thus, "spontaneous combustion" is often accused of fires, simply because no other reason for them can be ascertained. The ascription of phenomena whose cause was unknown, to electricity, was a pretty frequent exhibition of this fallacy a few years since, and the presumption that spirits rap tables or move furniture affords another instance. To establish a probability that a particular cause has operated, we must show that the action to be examined was one which the alleged cause was sufficient to produce, and that it had some special character corresponding with that cause.

The calculations of philosophers often take the form of a series of probabilities. Thus, a group of incidents, astronomical or physiological, all agree in some important particular. The probability of this agreement being the result of chance is found to be exceedingly small, and thus the probability of its being the result of some

law common to all the bodies acted upon is proportionably great. New views of astronomy such as those so ably thought out by Mr. Proctor, Darwinian theories, etc., all involve a nice application of the doctrines of probability. In some of these cases the elements to be computed are known. What are the chances that so many bodies under certain influences will do certain things? This is an inquiry that frequently admits of accurate solution, because sufficient data for the calculation can be obtained.

The philosopher who theorizes on such questions as the origin of species makes a series of assumptions all based on doctrines of probability. He thinks it probable that the operations of nature are conducted upon a uniform plan, that natural laws are unchangeable; that so many thousand instances indicating a special line of causation are probably to be relied on as demonstrating its existence. The opponent of such views seeks to demonstrate an overwhelming probability of some sure fact or law inconsistent with this train of reasoning.

In the absence of certainties, the rational study of probabilities becomes one of man's most important and most arduous tasks.

PHYSIOLOGICAL EFFECTS OF GREAT HEIGHTS.

In "Comptes Rendus," for 20th September, 1869, is a paper by M. Lortet, on Perturbation of Respiration, Circulation, and especially of Calorification at great heights on Mont Blanc, which proceeds as follows—

On the 17th and 26th August, 1869, I twice ascended the highest summit of Mont Blanc. In the interval, I passed the Col du Geant twice, and before my return to Lyon I climbed up several elevations, in order to verify the results which I had obtained concerning the disturbance occasioned in different physiological functions, by a visit to, or a walk up great heights. The instruments I employed were the anapnograp of Bergeon and Kastus, the sphygmograph of Marey, and the maximum air-bubble thermometer, constructed by Baudin, and easily reading to the 1-100th of a degree. As one ascends from a low region to a very considerable altitude, the physiological disturbance becomes more and more great. Scarcely appreciable in going from Lyon to Chamounix, it becomes very sensible between Chamounix and the Grand-Mulets (from 1000 to 3050 metres); still more so between Grand-Mulets and the Grand Plateau of Mont Blanc (from 3050 to 3092 metres), and at last it

is very considerable between the Grand Plateau and Bosses du Dromadaire (4556 metres), and the summit of the "calotte" of Mont Blanc (4810 metres).

Respiration.—From Chamounix to the Grand Plateau, from 1050 to 3932 metres, the disturbances of respiration are slightly noticed by those who know how to walk up high mountains, with the head lowered to diminish the orifice of the respiratory channels, and the air permitted to pass through the nose only, while the mouth is kept shut, and holding some small inert body, such as a nut, or a little stone, which augments the salivary secretion. Between Chamounix and the Grand Plateau, the number of respiratory movements is scarcely modified; we found them 24 per minute as at Lyon and Chamounix, but between the Grand Plateau and the Bosses du Dromadaire, we found them 36 per minute; and the breathing is short and troubled. It seems as if the pectoral muscles were stiff, and as if the sides were compressed in a vice. At the summit, after two hours walk, these feelings gradually went away, respiration went back to 25 per minute, but it was oppressed, and the anapnograph showed that the quantity of air inspired and expired was much less than in the plain, and the air, being at a low pressure, brought little oxygen in contact with the blood.

Circulation.—During an ascent, although the walk may be extremely slow, the circulation is highly accelerated. At Lyon, during repose and fasting, the mean figure of my pulsations was 64 per minute. In climbing from Chamounix to the top of Mont Blanc, it rose according to the altitudes, to 80, 108, 116, 128, 136, and finally, in ascending the last slope which conducts to the Bosses at the top, to 160, and even more. These slopes are very abrupt, between 45 and 50° of incline, but the rate of walking was necessarily slow, 32 steps a minute, and often less. The pulse becomes febrile, rapid, and insensible. One feels that the artery is almost empty, and the slightest pressure stops the current; the blood passes with great rapidity through the lungs, and this is one cause of its imperfect oxygenation, added to that of the rarification of the air. After reaching a height of 4500 metres, the veins of the hands, the fore arms, and the temples swell, and every one, guides included, feels a dullness in the head, and often a very distressing somnolence, due evidently to a venous stasis, and defective oxygenation. But after two hours complete rest and fasting, the pulse remains between 90 and 108. The sphygmograph applied to the wrist after an hour's repose indicated a very weak tension, and a very pronounced dicrotism.

When the sphygmograph is applied to subjects attacked with the "mal du montagne," it gives curves which exactly resemble those obtained in cases of freezing, the pulse is so weak that the spring of the instrument is scarcely elevated, and that alone indicates a general cooling of the body.

INTERNAL TEMPERATURE.—The internal temperature of the body was always taken with great care at different altitudes, the thermometer being placed in the mouth under the tongue, the mouth being closed, and respiration permitted only through the nose. The thermometer employed was a maximum one of Walfordin, with an index showing 100ths between 30° and 40°, the instrument was left in the mouth at least 15 minutes a time, more than sufficient for it to reach its maximum.

Fasting and walking the decrease of temperature is very remarkable, and is proportionable to the altitude.

M. Lortet gives the following table.

TEMPERATURE UNDER THE TONGUE.

STATIONS.	HEIGHTS.	Ascent 17 Aug., 1869.		26 Aug., 1869.		Air Temperature.	
	Metres.	Stationary	Walking	Stationary	Walking	17 Aug.	26 Aug.
Lyon	200	36·4	36·2			+22·7	
Chamounix	1050	36·5	36·3	37·0	35·3	+10·1	12·4
Cascarde du Dard	1500	36·4	35·7	36·3	34·3	+11·2	13·4
Charlet de la Para	1605	36·6	33·3	36·4	33·4	+11·8	13·6
Pierre-Pointu	2049	36·5	33·3	36·4	33·4	+13·2	14·1
Grand-Mulets	3050	36·5	33·1	36·3	33·3	— 0·3	— 1·5
Grand-Plateau	3932	36·3	32·8	36·7	32·3	— 8·2	— 6·4
Bossu du Dromadaire...	4556	36·4	32·2	35·7	32·3	—10·3	— 4·2
Sommet du Mont Blanc	4810	36·3	32·0	36·6	31·8	— 9·1	— 3·4

We thus observe, that during the muscular effort of the ascent, the internal temperature of the body may fall from 4 to 6°, when an elevation of 1050 to 4810 metres is reached, an enormous reduction in a mammal. If one stands still for a few seconds, the temperature reascends abruptly to merely its normal maximum. At the top of Mont Blanc, however, where every one feels a little discomfort, it was half an hour before the thermometer reached the normal point.

These data are not true during digestion, for then, in spite of the efforts the ascent necessitates, the temperature is maintained at from 36 to 37°, and even exceeds 37·3°. The influence of nourishment does not, however, last long, and an hour after having eaten, the body grows cool again under exertion.

From whence does this abatement of temperature arise? In

a state of repose and fasting the man burns the materials of his blood, and the heat developed is altogether employed in maintaining its temperature constant amidst the variations of the atmosphere. On the plains, muscular efforts, in proportion to their force, augment respiratory combustion, as M. Gavarret has shown. There is a transformation of heat into mechanical force; but from the density of the air, and the quantity of oxygen inspired, sufficient heat is developed to replace the loss. Up the mountain, on the contrary, especially at great heights, and on steep snowy slopes, where the mechanical work of ascending is considerable, an enormous quantity of heat is required for transformation into muscular force, and more heat is consumed than the organism can supply; and thence arises the cooling of the body, and the necessity for frequent halts, in order to warm oneself. Although the body is burning, and often in perspiration, it cools in the ascent, because it uses up too much heat, and respiratory combustion cannot supply a sufficient quantity, on account of the rarity of the air.

The rapidity of the circulation is also a cause of the cooling, as it does not give the blood time for oxydation. At a great height, as M. Gavarret has shown, the respiratory and circulatory movements not only help to render possible the absorption of a suitable quantity of oxygen, but likewise to relieve the blood of excess of carbonic acid. But this gaseous exhalation, although active, is insufficient to maintain the blood in a normal condition, and it remains overcharged with carbonic acid, producing occipital headache, nausea, a somnolence often irresistible, and that still more considerable cooling which affects travellers and guides who go beyond 4,000 or 4,500 metres in height.

The discomforts known under name of "mal du montagne," which attacked two of my companions with great intensity, was due especially to this considerable reduction of the temperature of the body, and probably also to a vitiation of the blood by carbonic acid. During digestion the cooling is almost nil, and that explains the habit of the guides to eat about every two hours. Unfortunately, above 4,500 metres the failure of appetite becomes so decided, that it is most often impossible to swallow a few mouthfuls of food. The secretions did not exhibit any peculiarities. Urine contained neither sugar nor albumen, but was noticeably diminished.

WINDVOGELBERG-KLOOF.

BY G. E. BULGER, F.L.S., F.R.G.S., C.M.Z.S., ETC.

WINDVOGELBERG is a lofty and isolated mountain of British Kaffraria, 5344 feet above the sea-level, and situated in about 32° 17′ 50″ S. lat. and 27° 7′ 3″ E. long. It lies nearly ten miles to the southward of the Great Kei River—which divides Kaffraria from Kaffirland and the province of New Victoria—and is, perhaps, double that distance to the northward of the far-famed Amatolas. For miles around extends an almost treeless, rolling, grassy country, occasionally intersected by small rivers, and, to the northward and eastward, diversified by rocky eminences of varying height. None of these latter, however, approach in altitude to the Windvogelberg, which is the loftiest peak between the Amatola range, and the still higher mountains about Queenstown—forty miles further to the northward. Near the southern foot of this great hill, and probably a thousand feet below its summit, stands a little mud redoubt, in which I resided for portions of 1863 and 1864.

The sides of the Windvogelberg mountain are very steep and craggy, presenting, here and there, perfectly sheer precipices, either destitute of vegetation, or displaying only a few straggling plants, that have found root-hold in the clefts and fissures of the rock. The summit is nearly flat, and is covered with a thin, coarse grass, and a few stray bushes. Almost directly behind the military post, a large ravine opens which divides the mountains at its base into two parts, but, decreasing rapidly in width and depth, with the ascent, it entirely disappears near a spring on the top. Here is the source of a little stream that finds its way down through the ravine, or kloof, as it is called, to the plains below, and finally falls into the Thorn River, about two miles below the post. The borders of this brook, until it emerges from the mountain, are ornamented with a few trees and many bushes, but the former are all of diminutive size—the larger ones having been cut away for fuel and other purposes.

At all seasons of the year the kloof is a pleasant and attractive place to the lover of nature, for it abounds in birds and flowers, but, during the southern spring-time it is especially bright and captivating. One lengthy ramble that I enjoyed amidst its varied beauties, early in October, 1863, will not readily be blotted from my remembrance. For some days previously there had been a succession of warm, genial showers of rain, and the whole country round was already responding to their life-giving influence with a

brilliant verdure, such as even merry England in her "month of rosy beauty" might well be proud of. We started early, notwithstanding that the sky looked somewhat dark and threatening, and amply were we repaid for having risked a wetting. The valley of the little river was in the fullest glory of its loveliness. Reeking with moisture and studded with exquisite flowers, it was wonderfully fresh and charming; looking, indeed, as if the trees and lesser plants had arrayed themselves in their richest and gayest robes for some grand festival of nature. A beautiful white iris, with purple and yellow markings, was very plentiful, and gladioli of many kinds, with their bright blossoms of scarlet, rose colour, and yellow, were scattered about in all directions amongst the rocks and long grass of the mountain-side; but, conspicuous above all for splendour, was one glorious plant, which we accidentally discovered peeping out of the green herbage at a little distance from the stream. It was the magnificent Tambookie Thorn (*Erythrina acanthacarpa*) of which a lot of young shoots, about six or eight inches in height, were springing from a thick, woody root: they were covered with new leaves and gorgeous flowers, the latter shaped somewhat like pea-pods, but velvety-looking, and of a lustrous scarlet-crimson, tipped with emerald.

Close by, in some swampy ground, we picked the first orchids of the year, a small species of *Disa* with a yellow blossom, probably *Disa chrysostachya*. Then a plant of *Cyrtanthus angustifolius* attracted our attention, glowing like a meteor amidst the green grass; and, soon afterwards, we found a number of old friends in the shape of English buttercups (*Ranunculus sceleratus*). The species of gladioli were very numerous, but it was exceedingly difficult, without some special guides, which we did not possess, to identify them. A grey one was probably *Gladiolus tristis* of Thunberg, and a pink one, *Gladiolus floribundus;* but there were, at fewest, seven or eight different kinds, exclusive of the scarlet *Watsonia angusta*, whose brilliant blossoms were most striking and conspicuous. Amongst the trees were *Cussonia spicata, Plectronia ventosa, Olea capensis*, the South African castor-oil plant (*Ricinus lividus*), the wild plum (*Sapindus pappea*), *Physalis arborescens, Celastrus buxifolius*, and *Schotia latifolia*. A species of mistletoe with white berries—probably the common *Viscuin capense*—was tolerably abundant, as well as the curious little leafless parasite, *Cassyta filiformis*.

The whole of the small forest on the banks of the rivulet is laced together by the twining shrub known as baboon's rope (*Periploca secamone*), and it forms, in many places, a dense screen of leaves,

which effectually shades all below it from the power of the sun. Under these conditions some of the huge boulders that everywhere stud the bed of the stream are pleasant places for a mid-day rest; and on one of them, which had evidently at some, perhaps not very distant, period, occupied a much more elevated position on the neighbouring mountain, we seated ourselves to enjoy for half an hour or so the agreeable shade, and the exceeding beauty of this little court of fairy-land. The clear waters of the brook wound in and out amongst the many obstructions to its course; here dashing down a small descent in a mimic cataract, there gliding smoothly round some tiny bay, and again, plumping over a larger rock in a concentrated stream of sufficient size to create a little waterfall of considerable force.

"I chatter over stony ways,
In little sharps and trebles;
I babble into eddying bays,
I babble on the pebbles.

* * * * *

And here and there a foamy flake
Upon me as I travel;
And many a silvery water break,
Above the golden gravel."

All round us were thousands of the lovely purple crested flowers of *Polygala bracteolata*, which is one of the commonest shrubs in the kloof; and by the edges of the stream, nestling in shady corners, were large masses of a charming little white blossom, which I took to be that of *Ornithogalum niveum*. From the margin of the water to half the height of the mountain, seemingly accommodating itself to every species of soil, and every position, was the white iris, with purple and yellow markings, already alluded to, which my companion declared to be the loveliest of the whole Cape flora. The common English chickweed (*Stellaria medea*), also, with its beautiful little white, star-like flowers, was tolerably abundant, especially near the water's edge. It is not, I understand, indigenous to the country, but an importation from Europe.

As we approached the source of the stream, there were a few acres of uncommonly nice looking snipe ground on either side of the path, but no birds could be found, nor were there any symptoms of their presence visible. We observed here, however, a handsome yellow iris, which was not growing on the lower ground, and which, at this elevation, seemed to have taken the place of the white one, already twice mentioned. A short distance further on, we met with

a curious bush, which was quite new to us; it had red papilionaceous blossoms, and an unpleasant smell, like roast mutton a little tainted. It was *Melianthus comosus*.

The view from the summit of the mountain, looking northward, is one of the strangest eye ever gazed upon. Mountains of the most surprising and fantastic outlines crowd in the prospect like a great ocean of stormy billows. No trees, no houses, not a vestige of humanity, or, indeed, life of any kind, but a wilderness of remarkable and lonely hill-tops, which, in eccentricity of shape and appearance, surpasses anything of the kind I have elsewhere seen. One very high peak, surmounted by an enormous truncated cone, towers above all the others in its solemn majesty. It is Hanglipp, the loftiest summit in the Queenstown district, 6,800 feet above the level of the sea.

As the season advanced, the flowers became more numerous, and, if possible, more attractive. We soon had the craggy sides of the mountain gay with exquisite little pelargoniums of various species, amongst which, perhaps, the handsomest and most abundant was *Pelargonium cardiophyllum;* while every here and there the gorgeous scarlet blossoms of *Crassula falcata* stood out conspicuously from the background of sombre-coloured rock, or the whitish green of its own peculiar leaves and branches. The frail, but lovely *Anemone caffra* also came to deck the hill-sides, along with *Cyrtanthus uniflorus*, purple orchids, blue lobelias, and yellow everlastings. Then, below the western summit, where the rocks are continually wet with the trickling of little streamlets from above, the magnificent *Amaryllis belladonna* grew most luxuriantly, and *Agapanthus umbellatus* reigned supreme in the azure glory of its charming bloom. Further down, *Cyrtanthus obliquus* was to be seen amidst the strange green blossoms of various kinds of euphorbias, at least one species of *Tritoma*, and the beautiful little *Anstea pusilla*.

Along the southern slope of that portion of the mountain just referred to the soil is of great richness, and there the South African wormwood (*Artemisia afra*) used to spread in a thick noble carpet over two or three acres of ground, filling the air with perfume, and seemingly furnishing immense attraction—of what kind I know not—to numbers of sun-birds, whose brilliant plumage caught the eye in all directions, as they flitted hither and thither. *Nectarinia famosa* literally abounded in that locality, and, on one occasion, being desirous of procuring a specimen of the female, I proceeded to the kloof and shot the first I saw, to the very great grief of her mate,

who seemed at his wit's end with sorrow and bewilderment when he found that his little partner would not respond to his most anxious appeals. He kept flitting about the bush where she lay, calling on her incessantly in a peculiar, piteous, pleading tone of voice that I had never observed before. The evident grief of the poor little creature was really painful to witness, and I felt that I would have given a good deal to have been able to undo my work of destruction, and restore the dead bird to life again.

Late in the summer, one of my companions found, close to the little kloof river, but on perfectly dry ground, a most lovely terrestrial orchid, which possessed a faint odour like that of cloves; the blossom was large and white, studded with purple specks. There were only two tubers and two flowers, all of which he secured. Both tubers, and one flower, were sent to England to a friend of mine, but, unfortunately, the former did not survive the voyage, and the latter reached him, I believe, in a most faded and discoloured state. I subsequently forwarded the second blossom to the late Professor Harvey, but it was so withered and changed in hue, that he could only hazard a guess as to the plant, which, he said, was probably *Disa macrantha*. Other orchids, whose names I know not, were also brought to me from the kloof, as well a very lovely little white primrose, and, from the very summit of the mountain, the splendid blossoms of *Sutherlandia frutescens*.

Saxicolas are abundant amongst the rocks in the kloof, and, in addition to the common mocking bird (*Myrmecocichla formicivora* of Hartlaub) I procured examples of *Saxicola pileata*, *S. sperata* and *S. sinuata*, as well as of a rarer kind which my friend, Mr. Layard, the curator of the museum at Cape Town, declared to be a new species. It was named and described as *Saxicola spectabilis* by Dr. Hartlaub, in the proceedings of the Zoological Society of London for 1865, p. 428; in which there also appeared (Plate xxiii.) a coloured illustration of male and female. Subsequently, however, Dr. Hartlaub informed Dr. Sclater* that the species was certainly identical with Temminck's *Saxicola bifasciata* (Planches Coloriées 472). This one, like all the rest of the tribe, which have come under my observation, is exceedingly tenacious of life, and has a habit of stretching out its neck and looking round it inquisitively.

Near the summit of the mountain, there are a few plants of that strange looking cycad, the *Encephalartos caffer* of Lehmann, and, amongst them I invariably found half a dozen or so of those noisy woodpeckers, *Colaptes olivaceus*, as also one or two bacbakiri

* "Proceedings of Zoological Society," 1866, p. 22.

shrikes—the elegant *Telophonus bacbakiri*—their yellow heads being very conspicuous as they ran about amongst the stones. Another fine shrike, called by the colonists the fiscal, *Lanius collaris*, a bold and fearless bird, that, I think, might easily be kept in confinement, and the handsome red winged spreeuw (*Juida morio*) were also to be seen occasionally.

One thick cluster of bushes, close to the water, was the permanent residence of a colony of moure-birds (*Colius striatus*), and the secret recesses of this little thicket furnished me, at various times, with not a few ornithological rarities. Amongst them was a pair of bulbuls (*Pycnonotus nigricapillus*) which Layard says * are the only examples of the species that he has seen; they were creeping about the bushes like titmice, and uttered no sound that I could hear. Also a male of *Crithagra butyracea*, the only one of the kind that I have met with, and a male of *Petrocincla explorator*, which is a rare bird in the vicinity of Windvogelberg. Its cousin, however, the blue rock-thrush (*Petrocincla rupestris*), is much more common, and I procured a number of specimens, chiefly from the naked crags near the summit of the mountain. Some of the habits of this latter bird are very suggestive of those of many woodpeckers; and, on several occasions I was quite deceived by the way in which they clung to, and crept about the trees. Doves of at least two kinds, *Turtus semitorquatus* and *Turtus senegalensis* are met with in the kloof, and I think a barbet, for one day in summer I heard a sound which carried me back in memory straight to the Burman jungles, where, in 1858, I used to listen with interest and curiosity to the singular metallic note of the "coppersmith" (*Xantholama Indica*): it was probably the call of *Laimodon unidentatus*, but, notwithstanding careful researches, I was unable to find the bird.

The mountain abounds in rock-rabbits (*Hyrax capensis*), but they are timid little creatures, rarely seen, and still more rarely shot. These, with the exception of, now and then, a stray family of rheebok (*Pelea capreola*), from the plains below, and a few *Muridæ* are, probably, the only representatives of mammalia at present at Windvogelberg, though it is not many years since lions made their homes amongst the numerous crags and caverns. One interesting little creature came more than once under our notice. In the early part of the summer of 1863, whilst wandering up the kloof, a friend of mine saw a tiny quadruped come out of a beautiful nest resembling that of the English dormouse, and, after I had left the post, in reference to this incident, he wrote to me as follows:—"One of the

* "Birds of Africa," p. 140.

men of the detachment brought me three pretty little creatures like dormice, which he had found hybernating in a kind of nest in a crevice of the rocks on the mountain. I had no difficulty in identifying them as belonging to the species *Graphiurus capensis*, and as similar to the one which, you will remember, I saw some months ago in the same locality. I shall tend them carefully, and try to tame them, and I fancy they will soon become great pets, they are exquisite little things—prettier even than our dormice in England. They seem very fearless already, and will eat without hesitation whilst I am watching them, so I have great hopes of their becoming 'humanized.'" Susequently he wrote again:—"Little mice getting tamer, I take them in my hands, but they still bite me now and then. I fancy they will tame easily, they sleep in a kind of nest all day, and are active only at night: I expect when the cold weather sets in they will go to sleep altogether. They are jolly little things—more like squirrels than mice." Soon after this, they unfortunately escaped, and my friend's observations were brought to a sudden close.

Reptiles, and other noxious creatures, were, I regret to say, more than sufficiently plentiful. That most deadly of serpents, the cobra-di-capella (*Naia haje*), and the almost equally dangerous puff-adder (*Clotho arietans*) frequently occurred, while scorpions and other snakes literally abounded, including the tiny *Stenostoma nigricans*. There were also a number of lizards, but I knew little about them, and only identified three kinds, viz. *Euprepes Smithii*, *Euprepes Olivierii* and *Gerrhosaurus flavigularis*.

NEW GUNPOWDERS.

BY M. BRUGERE.

THE following paper is taken from "Comptes Rendus," 20th September, 1869.

Picrate of ammonia in contact with a substance in ignition does not detonate as do most of the other picrates. It inflames without explosion, burns slowly with a reddish flame, and leaves a strong deposit of carbon. The idea occurred to us of mixing this body, so rich in gas, with saltpetre, and we have obtained *slow powders*, the rapidity of whose combustion varies according to the proportions of the components. That which has given the best results for use with guns, is formed of—

54 parts of picrate of ammonia.
46 „ saltpetre.

In the combustion of this mixture, all the carbon is burnt, and the residue consists entirely of carbonate of potash. The reaction is explained by the subjoined formula: $C^{12}H^{2}(AZO^{4})^{3}AZH^{4}O^{2} + 2(KO, AZO^{5}) = 10CO^{2} + 6AZ + 6H + 2(KO, CO^{2})$. We admit, what is sensibly true, that the gaseous products arising from the combustion of this powder in a closed space, only comprise permanent gases, with the exception of carbonic acid. According to these equivalents, 100 grammes of this powder should furnish in burning 38·86 gr. of carbonate of potash, and 69·14 gr. of gaseous products, occupying, at the temperature of zero, and under normal pressure, a volume of 52·05 lit.; but we have found in practice that the volume of gas is smaller, and that the quantity produced by 100 grammes of the powder is only 48 litres. According to Bünsen and Schirchkoff, 100 grammes of common powder yield, on combustion, 68·06 gr. of solid residue, and 31·38 gr. of gaseous products, which at zero, under normal pressure, occupy a volume of 19·094 lit. We see thus, that the comparative results of these two powders is expressed by $\frac{48}{19.094}$, or about 2·5.

The picrate of ammonia powder, made as above described, inflames, with detonation, on the approach of an ignited body, but it will not explode with a blow. Heated cautiously—in a sand-bath, for example—it undergoes no change up to 150°, when it assumes an orange-red tint. At 190° the picrate of ammonia begins to volatilize in yellow fumes, which grow more dense as the temperature is increased. At 300° the saltpetre melts, and at 310° an explo-

sion ensues. If the temperature is maintained between 200 and 250 degrees, we can remove the whole of the picrate of ammonia by volatilization.

Made up in cakes, this powder burns with a mean rapidity of 0·006 m. per second, the rate of combustion of ordinary powder in the same condition being 0·011 m. per second. We have not yet determined the temperature of this combustion. By the prolonged action of water this powder decomposes, yielding picrate of potash, and nitrate of ammonia.

After four months' experiments in our own laboratory and in that of the Ecole d'Artillerie, at Grenoble, we consider that the picrate of ammonia powder has the following advantages over common powder.

(1.) It is more homogeneous, and in consequence its effects are more regular. It is composed of two substances which crystallize easily, and can be readily obtained in a state of purity.

(2.) It is less hygrometric: 2 grammes of this powder dried over quick lime, and then exposed to the air in our laboratory, absorbed 0·007 gr. of water, whilst 2 grammes of common powder, under the same conditions, absorbed 0·025 gr.

(3.) With equal weights it produces much stronger effects. In different trials with a Chassepot gun, we have found that 2·60 gr. of this powder communicated to a ball the same velocity as the regulation charge—5·50 gr.—of common powder. The cartridges were made up to regulation length by 12 small wads placed between the powder and the ball, and which necessarily absorbed a valuable part of the force.

(4.) The solid residue is less—about $\frac{1}{4}$—in proportion to the effect produced.

(5.) The residue, composed almost exclusively of carbonate of potash, has no action on metals.

(6.) The smoke is almost done away with, and there is no smell. What little smoke is seen, arises from the combustion of the oxygen of the air with the nascent hydrogen, and which occasions a watery mist.

The hardness of the grains, and their density at the temperature at which inflammation occurs, are about the same with this and with ordinary powder. Picrate of ammonia powder costs four francs a kilogramme, and when allowance is made for the difference of effect, it comes to about the same price as ordinary powder.

The experiments in shooting which we have already made, are not sufficiently numerous to illustrate all the properties of the

picrate powder, but we hope to make others on a larger scale, under the authorization of the Minister of War.

Picrate of ammonia, united to bichromate of potash, gives a powder which appeared to us of a shattering character; but the residue composed of carbonate of potash and sesquioxyde of chromium, is considerable, and we have not tried this composition for shooting.

By mixing 25 grammes of picrate of ammonia, 67 of nitrate of baryta, and 8 of sulphur, we obtain a powder which burns very slowly, and in successive layers. Its rate of combustion is 0·040 m. per minute, that is to say, 20 times less than that of common powder. The flame which it makes is extremely bright, and of a beautiful green. This composition might be employed as a Bengal light. It has the great advantage of making no smoke and having no smell.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LAT. 51° 28′ 6″ N. LONG. 0° 18′ 47″ W.

BY G. M. WHIPPLE.

(BY PERMISSION OF THE METEOROLOGICAL COMMITTEE.)

(*With a Plate.*)

JULY, 1869.

ATMOSPHERIC PRESSURE.—The month passed without any remarkable features in the movement of the barometer. Little alteration took place in the mean height during the first three days, on the 4th there was a decline, and a still farther one on the 5th, that day's being 29·889 ins.

The next day there was a steady rise from noon to 10 P.M., but it diminished a little on the 7th; however a continuous upward movement took place from 4 P.M. on the 8th to 10 A.M. on the 10th, at which time the highest reading during the month was recorded, and that day's mean, 30·380 ins., was the greatest.

The readings rapidly diminished from 8 A.M. on the 11th to the same hour on the 12th, reducing the mean to 30·058 ins. At 7.30 P.M. the barometer began to rise, oscillating considerably, and at

6.45 the next morning an almost sudden depression of 0·075 ins. was registered, which lasted 17 minutes, the barometer then recovering its former position—a similar depression of 0·035 ins. took place at 7.30 P.M., and lasted 15 minutes, after which the barometer became stationary. A slow decline of means from 30·248 ins., on the 14th, to 30·006 ins., on the 18th, was followed by an increase to 30·143 ins. on the 20th.

On the 22nd the barometer fell between 1 A.M. and 4 P.M., it then rose until 9 A.M. of the 23rd, after which there was a steady diminution of pressure until the 26th, that day's mean, 29·781 ins., being the lowest of the month.

A general rise followed, broken in its regularity by a series of oscillations which lasted from 6.30 A.M. to 2 P.M. on the 28th, and terminated in a rapid fall until 4 P.M., after which the barometer became steady.

The mean height for July was 30·068 inches.

TEMPERATURE OF THE AIR.—The mean temperature was 55·7° on the 1st, and scarcely varied until the 4th, when it rose to 62·6°.

The next abrupt change was from 63·7° on the 11th, to 71·7° on the 12th, followed by a sudden decline to 59·3° the next day; afterwards the increase was regular to 72·1° on the 17th. The themograph record for the 19th shows a sudden diminution of temperature from 1 A.M. to noon, an elevation of 3° having then occurred, it remained nearly stationary until 5 P.M., when it recommenced falling, and continued until 6 the next morning. The result of the fall was a reduction of the daily mean to 58·1° on the 20th.

The mean for the 22nd, 72·4°, was the highest of the month, and the curve of means afterwards gradually declined to 55·1° on on the 28th, the lowest of the month.

On the 30th the thermometric trace exhibits the ordinary daily fall until 10 P.M., it then began rising and continued to ascend at an uniform rate for about 12 hours. The mean for the 31st was 65·0°.

The highest maximum temperatures recorded in July were 86·5° on the 16, 86·9° on the 18th, and 89·2° the 22nd; the lowest 62·8° the 28th, and 63·3° on the 1st.

The lowest minima were 48·5° on the 29th, and 48·7° on the 10th; the highest 61·5° on the 23rd and 31st.

The largest daily range was 37·9° on the 22nd, the smallest 10·6° on the 1st and 31st, and the mean for the month 20·8°.

The mean temperature for July was 63·5°.

RELATIVE HUMIDITY.—The extremes of humidity were 0·98 on

28th, and 0·50 on the 11th, 0·59 on the 9th and 17th, and the monthly mean was 0·71. Complete saturation being 1·00.

RAINFALL.—The rain measured was as follows:—

DAY.	AMOUNT.	DAY.	AMOUNT.
9.....	0·015 inch.	28.....	0·154 inch.
13.....	0·210 „	29.....	0·480 „

Total fall in the month being 0·859 ins.

WIND.—The general direction was:—

North—13th.
North-East—1st, 2nd, 17th, 19th, 28th.
East—3rd, 20th.
South-East—4th, 11th, 21st.
South—8th, 12th, 22nd.
South-West—5th, 7th, 18th, 26th, 29th, 30th, 31st.
West—6th, 9th, 10th, 14th, 23rd, 25th, 27th.
North-West—15th, 16th, 24th.

The principal features of the anemograph traces were as follows:—

The wind blew steadily from the east until 10 A.M. of the 4th, when it veered to S.E. At 9 A.M. next day to S., and shortly after to S.W., where it remained until the 10th. The velocity then diminished to 5 miles per hour, and the direction varied continually, shifting from W. through N. to E., then to S.E., where it remained. The velocity ran up to 30 miles per hour at 1 P.M., which rate lasted but a short time.

On the 12th the direction changed at 9 A.M. from E. to S. and S.W., where it continued until 10.35 P.M., when there was a sudden shift from S.W. to N.

The retrograde movement, N. to W., occurred at 11 A.M. on the 14th. There was very little wind through the 16th and 17th, until 5.10 P.M. on the latter day; a breeze of 15 miles then came up from the E., this changed the next morning at 8 to S.W.

During the night of the 20th a gradual change from E. to S. was registered, and during the 24th and 25th the vane made several revolutions, the winds being light. On the 28th there was a perfect calm from 1 to 5 A.M. Through the 29th and 30th there was a steady S.W. breeze of 20 miles per hour.

The greatest passage of wind in 24 hours during the month was 394 miles, on the 30th; and the least 90 miles, on the 16th.

August.

Atmospheric Pressure.—There was a somewhat larger range of barometer in August than in the preceding month, but still no excessive movement occurred. A slight diminution in the mean height took place between the 31st of July and the 1st, 29·840 ins. being the reading for the latter day. Afterwards no change was registered until 6 P.M. of the 3rd, when the mercurial column began to ascend, and continued rising until 6th, 10 P.M., causing an increase in the means from 29·837 ins. on the 3rd, to 30·290 on the 6th. The downward movement commenced at 11 A.M. on the 7th, and continued uniformly until midnight of the 8th, at which hour the lowest reading of the month was recorded. Shortly after, at 1 A.M., 9th, a series of oscillations occurred, and at 6.30 P.M. the barometer began to rise steadily, but came to rest at midnight.

The mean reading for the day was 29·586 ins. Afterwards there was a gradual upward movement until the 17th, interrupted only by a fall from 8 A.M. to 4 P.M. on the 13th, and the mean for the former day 30·343 ins. was the maximum in the month.

The barometer was almost stationary until 10 A.M. on the 23rd, when a slight fall took place, this, however, ceased at 4 P.M.; but on the 27th another fall was registered, which became somewhat rapid about 1 A.M. of the 28th, and was so maintained until 5 A.M. of the 29th. At 11 A.M. on the same day, a brisk upward movement set in which lasted to 9 A.M. of the 31st; some oscillations breaking the uniformity of the curve between 10 P.M. of the 29th and 2 the next morning. The means for the 29th and 31st were 29·958 ins. and 30·331 ins. respectively.

The mean height of the barometer for August being 30·108 ins.

Temperature of the Air.—Starting with a mean daily temperature of 60·6° on the 1st, we find that there was not a departure from this to a greater extent than 5° until the 25th.

Of the intervening days the curves for the 7th and 8th were very free from fluctuations, whilst in the succeeding days, the 9th and 10th, these were unusually frequent. Another period of oscillation was from 1 to 5.30 A.M. on the 18th.

The thermograph curve for the 22nd shows a very rapid fall between 5.40 and 8.0 P.M., followed by an absence of change for 12 hours.

From 67·6° on the 25th the means increased to 71·4° on the

27th; this was the highest attained in August; 70·9° was reached on the 28th.

A continuous decline in temperature took place from noon on the 29th to 6 A.M. on the 31st; reducing the means to 54·1° on the latter day.

The highest readings of the maximum thermometer were 85·5° on the 26th, and 87·6° on the 28th. The lowest of the same instrument were 62·4° on the 19th, and 63·4 on the 30th.

The lowest minimum readings were 43·5° on the 21st, and 43·0° on the 31st. The highest 58·6° on the 9th, and 58·2° on the 27th.

The extremes of daily range were 30·0° on the 21st and 25th, 10·1° on the 19th, and 11·3° on the 30th. The mean being 19·2°.

The mean daily temperature for August was 60·3°.

RELATIVE HUMIDITY.—This was generally high during the month, the depressions in the curve being 0·94 on the 3rd, and 0·95 on the 8th and on the 13th. The greatest dryness was 0·53 on the 30th and 31st, and the mean 0·72. Complete saturation being 1·00.

RAINFALL.—The rain measured was as follows:—

DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.
1.....	0·020 inch.	5.....	0·079 inch.	13.....	0·040 inch.
2.....	0·030 „	8.....	0·233 „	14.....	0·242 „
3.....	0·190 „	9.....	0·040 „	17.....	0·010 „
4.....	0·207 „	10.....	0·095 „		

The total fall in the month being 1·166 inches.

WIND.—The general direction of the wind was:—

North—5th, 29th.

North-East—17th, 19th, 20th, 30th, 31st.

East—6th, 26th, 27th.

South-East—28th.

South—21st.

South-West—1st, 3rd, 4th, 7th, 8th, 23rd, 24th.

West—2nd, 9th, 12th, 13th, 18th.

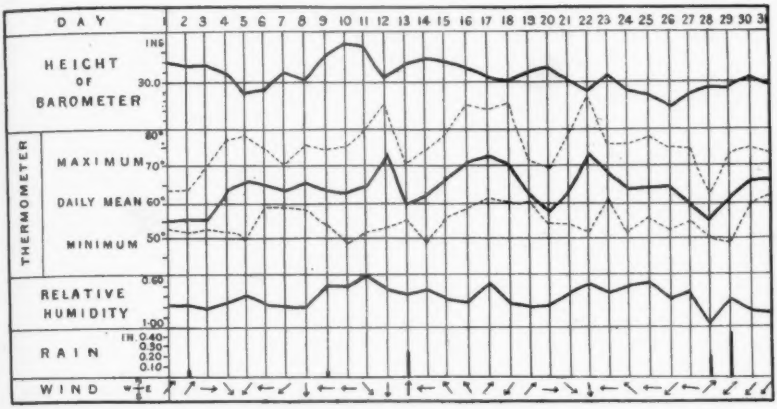
North-West—10th, 11th, 14th, 15th, 16th, 22nd.

The chief changes recorded by the anemograph were the following:—

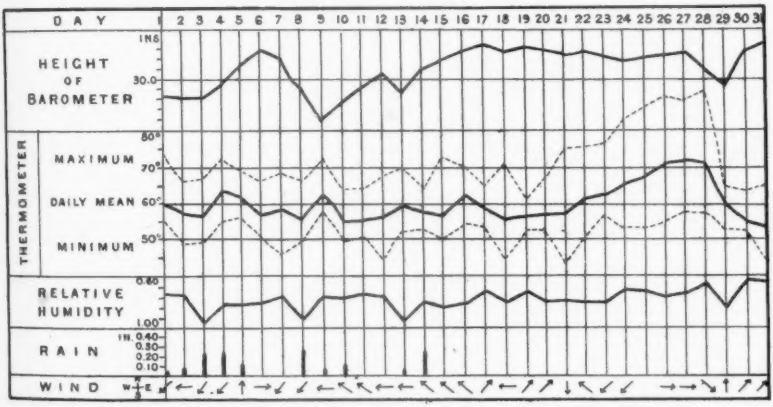
At midnight of the 6th, the wind, which had been blowing at 16 miles per hour from the E., ceased, but at 8.10 A.M. on the 7th it recommenced at the same rate, the direction being S. Between

DIAGRAMS, REPRESENTING THE METEOROLOCICAL VARIATIONS OBSERVED AT THE KEW OBSERVATORY.

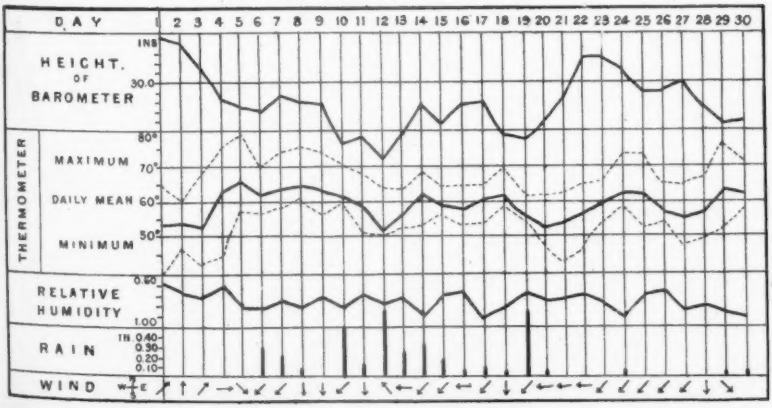
JULY, 1869.



AUGUST, 1869.



SEPTEMBER, 1869.



3 and 8 P.M. on the 13th, there was a steady veering S.W. to W. and back to N.W. A calm was registered from 6.10 to 8.10 P.M. on the 16th, succeeded by a breeze of 10 miles per hour, which diminished after midnight. Two changes occurred on the 18th, at 1.5 P.M. from N. W. to S.W., and at 9 P.M. from S.W. through S. to N.E. Another sudden change of direction was recorded at 6.5 A.M. on the 29th, from S.E. through E. to W. the velocity augmenting from 3 miles to 14, and afterwards at 1 P.M. to 25 miles per hour.

The greatest passage of wind in 24 hours during the month was 375 miles on the 30th; the least 46 miles on the 21st.

September, 1869.

Atmospheric Pressure.—The variations in atmospheric pressure were both more frequent and larger in extent in September than in either July or August. The barometer stood at its highest point, 30·390 ins., on the 1st. At first its fall was slow, becoming more rapid from 10 A.M. of the 3rd to 4 P.M. of the 4th. The next day, the 5th, the rate again diminished, but there were frequent oscillations of the mercurial column.

On the 6th, the mean was 29·724 ins. Afterwards there was a slight rise, but at 6 P.M. of the 9th a fast downward movement commenced, which lasted until 10 A.M. of the 10th; the uniformity of fall being interrupted by much oscillation between 4 and 6 A.M., and by two sudden elevations, the one of 0·041 ins. registered at 5.35 A.M.; the second, 0·072 ins. at 5.58 A.M.

Between 6.40 P.M. and midnight, a steady rise occurred; after which the barometer was stationary until 4 P.M. of the 10th; it then fell rapidly until 5 A.M. of the 12th; an upward movement followed until 8 P.M., after which it went down. The mean for the day, 29·183 ins., was the lowest of the month.

The readings increased regularly from 2 P.M. of the 13th to 4 A.M of the 14th, the mean for that day being 29·794 ins. During the 15th there was oscillation, with a falling barometer; the next day it regained its former height. On the 18th there was another descent, accompanied with considerable fluctuation between 2 and 11 P.M. The mean for the 19th was 29·417 ins. From 4 P.M. of the 20th to the 22nd, a continuous rise took place, which raised the mean for the latter day to 30·186 ins.

By the 25th the mean had descended to 29·884 ins., and an irregular fall during the morning of the 29th still farther lowered it to 29·544 ins.

The mean height of the barometer for September was 29·775 ins.

Temperature of the Air.—Contrary to the ordinary march of temperature, the thermometer stood higher at the end than at the beginning of September. On the 1st, the daily mean was 52·9°, and on the 3rd, 52·7°; the means then increased to 65·0 on the 5th, which was the highest of the month.

The next large change was from 58·8° on the 11th to 51·3° on the 12th, followed by a rise to 60·5° on the 14th.

The thermograph traces show the thermometer to have been quite stationary from the 14th, 5 P.M., to the 15th, 5.10 A.M.; a sudden fall of 3° then occurred, and the ordinary daily curve commenced.

A depression in the means took place from 61·5° on the 18th to 51·9° on the 20th; after which there was a regular increase to 61·6° on the 24th. Another decline to 55·7° on the 27th was succeeded by a rise to 62·3° on the 29th, and 61·5° on the 30th. The curves for the nights of the 26th and 28th exhibited numerous fluctuations.

The highest readings of the maximum thermometer were 75·1° on the 4th and 29th, and 78·2° on the 5th; the lowest 61·1° on the 2nd and 19th.

The lowest readings of the minimum were 39·9° on the 1st, and 41·0° on the 3rd, the highest being 60·7° on the 8th.

The greatest daily range was 31·0° on the 4th; the least, 6·6° on the 19th, and the mean 15·1°.

The mean temperature for September was 58·5°.

Relative Humidity.—The extremes of humidity were 0·93 on the 14th, and 0·96 on the 17th; the opposite extremes being 0·59 on the 1st, and 0·62 on the 4th; and the mean, 0·76.

Rainfall.—The rain measured was as follows:—

DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.
6...	0·300 inch.	12...	0·685 inch.	16...	0·010 inch.	20...	0·015 inch.
7...	0·184 „	13...	0·200 „	17...	0·060 „	24...	0·030 „
10...	0·510 „	14...	0·315 „	18...	0·030 „	29...	0·006 „
11...	0·080 „	15...	0·144 „	19...	0·683 „	30...	0·015 „

The total fall in the month being 3·267 ins.

Wind.—The general direction was:—

North—2nd.

North-East—1st, 3rd.

East—4th.

South-East—5th, 29th.

South—8th, 9th, 11th, 18th, 28th.

South-West—6th, 7th, 10th, 14th, 15th, 17th, 19th, 23rd, 24th, 25th, 26th, 27th.

West—13th, 16th, 20th, 21st, 22nd.

North-West—12th.

The anemograph recorded the following changes:—

At noon on the 3rd, a change in direction from W. to E., and on the 4th, at 10.20 P.M. it went from E. to S. At 11.45 P.M. of the 9th, the wind made a complete circuit from S., through W., N., and E. to S. The velocity on the 10th increased between 3 and 1 P.M. to 30 miles per hour, and at 5 P.M. to the maximum velocity of 40 miles.

On the 12th, between 2.30 and 7 A.M., there was a steady veering in the direction from S., through E. and N. to W., the rate remaining at 25 miles throughout; but afterwards, between 10 A.M. and 5 P.M. of the 13th, this mounted to 35 and 40 miles. The same velocity was also reached between 3 P.M. of the 14th and 2 A.M. of the 15th.

On the 25th, between 2 and 4 P.M., the greatest rate did not exceed 30 miles. At 3 A.M. on the 29th, the direction changed from S. to E., returning at 8 A.M. to S. At 10.50 P.M. on that day, the velocity dropped from 12 to 2 miles, and the vane moved several times through large angles before it settled at S.E. at 9 A.M. of the 30th. Before 4 and 6 P.M. it again shifted from E. through S. to N.W., going back N.W. to S. at 10.20 P.M., the rate being from 5 to 10 miles per hour during the interval.

The greatest mileage of the wind in 24 hours during September was 574 miles on the 13th, and the least 103 on the 3rd.

THE MOHAMMEDAN HISTORY OF EGYPT.

BY E. H. PALMER, B.A.,
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CHAPTER III.

THE FÁTEMITE AND AIYÚBITE DYNASTIES.

On the death of the Emír Káfúr the kingdom became so distracted by the intrigues of opposite factions and the arrogance of the military, that the chief men determined to call in the assistance of El Moe'zz, Abu Temmím, the Fátemite. This prince was the fourth in succession from El Mehdi ibn 'Obeid Allah, who in the year 910 A.D. had usurped the government of Eastern Africa, and, throwing off his allegiance to the house of Abbás, had established a rival Caliphate in the West. After him came :—

2. El Cáim bi Amr illah, his son, A.D. 934—945.
3. El Mensúr Ismá'íl, A.D. 945—952.
4. El Moe'zz lidín illah, Abu Temmím Maa'dd, son of El Cáïm bi Amrillah, A.D. 952—969.

They founded their claims to the Caliphate upon their supposed descent from Fátimeh, the daughter of the Prophet. This pretension is rejected by most of the Mohammedan historians, who declare that the Fátemites were descended, on the father's side, from El Husein ibn Mohammed ibn Ahmed el Caddáh, a fire-worshipper, or as some say, a Jew, and on the mother's side from Fátimeh, the daughter of the Jew named 'Obeid. Their Caliphate is not acknowledged by the orthodox Moslems, both on account of the doubt concerning their origin, and because they set up their Caliphate while that of the Abbasides was actually in existence at Baghdád, it being impossible to recognize the claims of one without denying the legitimacy of the other, as two supreme heads of the religion could not hold office at one and the same time.

El Moe'zz at once acceeded to the proposed request made to him for assistance, and despatched Goher (or Jauhar) Abu l'Husein es Saqalí el Cáïd, with a large army, to invade Egypt. This Goher was a man of considerable ability, a native of Greece, and had been a slave of the Caliph's father, Mensúr. Meeting with little or no opposition on his entry into the country, he deposed the Sultan, and proceeded to take formal possession in the name of the Caliph El Moe'zz, whose name was proclaimed in all the mosques of Egypt on the following Friday. The Muezzins of the mosques of 'Amer

and Ibn Túlún were also ordered to substitute the Shiah for the Sunnite formula in the call to prayer, a measure which was received with the greatest dissatisfaction by the people.

The situation of Fustát not pleasing Goher, he determined to found a new capital, being probably stimulated thereto by the example of the Abbasides, who had so immortalized their renown by the building of Baghdád. When the trenches for receiving the foundations of the new city were completed, Goher caused wooden poles to be set up at the extremities of each trench, and connected them by ropes, upon which were suspended small brass bells. The astrologers then assembled in solemn conclave, and, having set up their instruments, awaited an auspicious moment for laying the foundation stones. It so happened that a bird alighting on one of the ropes, caused the bells to sound, and, accepting this as a favourable omen, the architects at once threw the stones which they held in their hands into the trenches, and the foundations were pronounced to be formally laid. At the same moment the astrologers cried out that the victorious one, *El Cáhir* (that is Mars), was in the ascendant, and foretold that the majority of the princes who should rule the city would be of Turkish descent. This prediction has certainly been verified. The Caliph El Moe'zz, when, shortly afterwards, he arrived in Egypt, disapproved of the site chosen by El Goher, and blamed him for not having founded his capital upon the banks of the Nile. The name originally selected for the city by Goher was El Mensúríyeh, but in consequence of the incident just recorded, it was changed to El Cáhirah, the Victorious, from the Italian corruption of which our own name Cairo is derived. The city is, however, called by the natives Masr, the name of the old capital which occupied the site of Memphis. Out of compliment to his master, Goher added the title Moezzíyeh, and the full apellation of the town became *El Cáhirat el Moezzíyeh*. El Moe'zz was a violent partizan of the Shiah sect, and lost no opportunity of evincing his hostility to the opposite persuasion of the Sunnis; but he was, nevertheless, a just and accomplished prince, and was esteemed even by his enemies and opponents. He showed great favour to the Christians, even rebuilding for them some of their churches in old Cairo; the grand mosque of El Ezhar, now one of the most important colleges in the East, was erected and endowed by him. He died in Egypt in the year 969, after a reign of little more than four years, and was succeeded by—

5. El 'Azíz billáh Abu'n Nasr Nizár, A.D. 969—975.

During the reign of this prince, the government of the country

was virtually administered by Goher; and El Azíz himself, after a long and chequered career, died in the baths at the City of Bilbeys.

After him came his son—

6. El Hákim bi Amr illáh Abu ʿAlí Mensúr, A.D. 996—1021.

This was the founder of the sect of the Druzes; his memory is held in universal detestation by the Mohammedans, who regard him as the most cruel and impious prince that had ruled Egypt since the Pharaoh who oppressed the children of Israel. Like that monarch he claimed for himself divine honours, and the Druzes, his followers, still look for his second advent upon earth. He commanded that whenever his name was mentioned in the Friday homily, in the mosques, all the congregation should rise up to do him reverence, and this was accordingly done throughout the realm, and even in the sanctuaries of Mecca and Medinah. So violent and fickle was he in his temper, and so reckless in the commission of the most enormous crimes, that it is scarcely possible to believe that he could have been sane. His death was worthy of such a life, for he was assassinated on Jebel Mocattem, whither he had gone one night to observe the stars, by the emissaries of his sister Seyidet el Mulúk, whom he had attempted to violate. The murderers carried his corpse to his sister, who buried it privately in her own house. He built the large mosque, now in ruins, which bears his name, situated near the Bab en Nasr. His avowed intention in the erection of this building, was to destroy the prestige of El Ezhar, but his vanity was never gratified by hearing his own name mentioned in the homily there, as it was not opened for public worship until the reign of his son.

7. Ez Záhir li din illáh Abu'l Hasan Ali, son of the last mentioned Caliph, A.D. 1021—1036.

He ascended the throne at the age of sixteen, and reigned for another sixteen years, with great moderation and ability.

8. Abu Ahmed el Mostanser billáh Maadd, his son, A.D. 1036—1094.

He began his reign at the early age of seven years, and continued to hold the Caliphate for nearly ninety years, the longest reign in the annals of Mahommedan sovereigns. In his time occurred the severest famine that had been known in Egypt since the time of the Patriarch Joseph. So great was the distress that a single cake of bread sold for five golden dinars, and on one occasion a woman offered a bushel of jewels for sale in the public streets for a bushel of corn, and being unable to find a purchaser, laid herself down to die of starvation. Other and greater horrors

attended this dreadful visitation, and several well authenticated cases of cannibalism are related to have occurred.

Taking advantage of some disturbances which had broken out in Baghdád, El Mostanser succeeded in causing himself to be proclaimed caliph in that city, and the insignia of the legitimate successor of Mahommed were solemnly forwarded to Cairo. El Mostanser was a weak and profligate prince, and had it not been for the decision and ability displayed by his vizier, Gemali, who took the administration of the government entirely into his own hands, the kingdom must have been irretrievably ruined. The fall of the Fátemite dynasty dates from the reign of this prince, for at his death the power fell virtually into the hands of the ministers of state, and the succeeding caliphs of that house were little better than puppets in the hands of the rival viziers, who were continually striving for the supreme authority.

9. El Mosta'lí billáh Abu 'l Cásim, the son of El Mostanser, A.D. 1094—1101.

In this reign occurred the first Crusade. El Afdhal, the vizier, having wrested Jerusalem from the Turks, was in turn compelled to surrender it to the Crusaders after a siege of forty days.

10. El 'Amir bi Aḥkam illáh abu 'Alí Mansúr, A.D. 1101—1130.

Began to reign when only five years old. He was an unjust and tyrannical prince, and was killed at the island of Rodha by the partizans of the vizier El Afdhal, whose son then usurped the government. The latter set up as Caliph—

11. El Háfiz li dín illáh Abd el Mézed Mohammed, a grandson of El Mostanser, A.D. 1130—1149.
12. Ez Záfir bi 'adá illáh Ism"áil, his son, A.D. 1149—1155.
13. El Fáïz 'Eisá li nasr illáh, his son, A.D. 1155—1160.
14. El "Adid li dín illah 'Abd allah ibn Yúsuf el Hafiz, A.D. 1160—1171.

The dissensions occasioned by the intrigues of the rival ministers, amongst whom the notorious Sháwer, governor of Upper Egypt, played a conspicuous part, at last consummated the ruin of the house of Fátimeh. El "Adil, the minister of the last Caliph, having procured the dismissal of Sháwer from his office, the latter attacked him with a considerable force, and succeeded in putting him to death. He was in turn defeated by Ed Dirghám, another competitor for the coveted post, but invoked the aid of Núr ed dín es Shahíd, sultán of Damascus, who sent a large army into

Egypt, under the command of Asad addín Sherkúyeh, and reinstated Sháwer in his govenorship. The ingratitude which Sháwer displayed for this service brought about a breach between him and the Syrian general, and being threatened by the latter with actual hostilities, he called in the aid of Amalric, the king of Jerusalem.

Sherkúyeh hereupon withdrew from Egypt, but returned some two years after, accompanied by his nephew, the famous Saláh ed dín (Saladin), and, gaining a victory over Sháwer and his allies, Alexandria, with other important towns, fell into the hands of the invaders. They were, however, shortly afterwards compelled to come to terms with the Crusaders, and again evacuated the country. Amalric, the Frank king, seized the opportunity of occupying the town of Bilbays, putting many of the inhabitants to the sword, and marched on to El Cáhireh itself.

On the approach of the Franks Sháwer ordered the old city of Fustát to be set on fire, to prevent it from falling into their hands, and this order was accordingly carried into effect, the conflagration raging for fifty-four days. In these emergencies Núr ed dín, at the earnest solicitation of the Caliph El ″Adid, again sent Sherkúyeh and Saláh ed dín into Egypt and so great was the terror which their names inspired that the Franks raised the siege and beat a precipitate retreat.

The first act of Sherkúyeh on his entry into Cairo was to put to death the Vizier Sháwer, whose treacherous communications with the Crusaders, had brought so much trouble upon the country. El ″Adid appointed Sherkúyeh in his stead; but the latter dying shortly afterwards, was succeeded by Saláh eddín. The new vizier, by the order of his master, Nur eddín, substituted the name of the Abbaside caliph in the public prayers for that of El ″Adid, who was then upon his deathbed, and the final blow was then given to the Fátemite dynasty, after they had ruled exactly two centuries. The vices of some of the earlier members of the family, and the weakness of the later ones, detract greatly from the glory of what promised to be an illustrious house.

Saláh eddín had from the very first cherished the design of making himself independent sovereign of Egypt, and the death of Núr ed dín happening opportunely shortly after that of El ʿAdid, he took advantage of the situation to cause himself to be proclaimed king, with the style and title of El Melik en Náser Sálah ed dín Yúsuf ibn Aiyúb. With him began the Aiyúbite or Kurdish dynasty.

Having possessed himself of the palaces and treasures of the Fátemite caliphs, and established himself firmly in the government of Egypt, he proceeded to employ the immense resources thus placed at his disposal in vigorously prosecuting a "holy war" against the Franks, whom he succeeded in driving out of the country, and wresting from them all their possessions in Syria and Egypt. These wars belong properly to the history of the Crusades, and are too long and complicated to be more than noticed here. Being himself a strong partizan of the Sunni sect, Saláh ed dín superseded all the Egyptian Cadhis and Sheikhs who were of the opposite Shiah persuasion, and restored the Sunni formula of the call to prayer, which had been abolished by El Mo'ezz's general. He presently extended his conquests over the whole of Hejaz, Yemen, and Africa, as well as Syria, and became the most powerful monarch in the East.

His piety and justice were as remarkable as his military successes; and if he did not found or endow so many colleges and mosques as some of his predecessors, he is acquitted by the Mohammedan doctors of want of liberality, on the ground of the enormous expenses which his "holy wars" entailed. The magnificent citadel at Cairo was built by him, and many other improvements effected in the town. He took his two sons, El Azíz and El Afdhal, to Alexandria, for the purpose of receiving instruction in the precepts of the Mohammedan traditional law from a celebrated theologian in that town, thus following the example of Harún er Rashíd, who carried his sons, El Amín and El Mamún, to Medíneh for a similar purpose.

During his reign the Franks attacked Damietta with 200 ships of war, but the sultán met them on landing, and drove them back with great slaughter. He reigned twenty-two years, from A.D. 1171—1193, and died at the age of fifty-seven, at Damascus, where he was buried.

2. El Melek el 'Azíz 'Othman, his second son, A.D. 1193—1200. The eldest son, El Melek el Afdhal 'Alí, received the government of Damascus as his portion, and Aleppo was given to his other brother, Ghiyas ed dín Ghází. He died at Cairo, and was buried in his own house, but his remains were afterwards removed to the Turbet es Sháfi'í (Shafi'í cemetery.)

3. El Melek el Mensúr Mohammed ibn Othmán, A.D. 1200, his son, ascended the throne at the age of nine, but was shortly afterwards deposed by his uncle the regent, and thrown into prison in the citadel, where he died.

4. El Melek el 'Adil Seif ed dín Abu Beker ibn Aiyúb, A.D. 1200—1218.

Salah ed dín's brother, the regent, then usurped the throne, in the year (1200) in which Sídí Ahmed el Bedawí, the great Egyptian saint, was born. His own name, and that of his son, El Kámil, were inserted together in the *Khutbeh*, or Friday Homily. In his reign the Divan was first removed to the Citadel, where its sittings are still held.

5. El Melek el Kámil Mohammed, A.D. 1218—1238.

The Crusaders having in the meantime carried on their wars with varying success since the death of Salah eddín, made another attack on Damietta in the reign of El Kámil, and even penetrated as far Ashmún, but here they were met by Kámil himself, at the head of a considerable force, who, by the skill and decision of his movements, compelled them to retreat, and evacuate the country. El Kámil died after a reign of twenty years, and was buried at Damascus.

6. El Melek el"Adil Abu Bekr, his son, A.D. 1238—1239.

He began his reign at the age of eighteen, but displayed such incapacity and injustice, that he was soon deposed and thrown into prison by

7. El Melek es Sáleh Nejm ed dín Aiyúb, his brother, A.D. 1239—1249.

He built a fort upon the island of Rodha, on the Nile (el Bahr el Kebír) and garrisoned it with a thousand Turkish slaves, whom he had purchased for the purpose. They were known as el Memálík el Bahrúyeh, the Memlouks or slaves of the Nile, and formed the nucleus of that body which subsequently exercised such an influence upon the destinies of Egypt. The Crusaders during this reign invaded Damietta, under St. Louis, and drove out the Egyptian governor with the entire population, who fled southwards towards Mensúrah, where the sultán, then dangerously ill, was residing. At this unfortunate juncture El Kámil died, but his widow, Shegeret ed Durr, with great presence of mind, caused his body to be secretly removed to Cairo for burial and concealed his decease from the military and people. The ministers who had been apprised of the event, then summoned Tawarán Sháh, son of the late monarch, from Diyár Bekr. He hastened to the spot, and by a vigorous attack and cutting off the supplies of the invaders, compelled them to surrender, and took St. Louis himself prisoner. The French king was kept in prison, under the care of an eunuch named Sabíh, until the reign of Shegeret ed Durr, who arranged for his release, on

the condition that the Franks should evacuate Damietta, liberate all the Mohammedan captives, and pay a sum of eight thousand dinars, as compensation for the property which they had destroyed or plundered.

8. El Melek el Moa'zzem Tawarán Sháh, A.D. 1249—1251,

Succeeded his father, but by his cupidity and debauchery rendered himself so obnoxious, that at the instigation of Shegeret ed Durr herself, the Memlouks formed a conspiracy and assassinated him.

9. Shegeret ed Durr Omm el Khalil, A.D. 1251,

Then assumed the reigns of government. She was the first woman who ever held sway in El Islám; her name was inserted in the public prayers, after that of the Abbásí Caliphs, and was inscribed upon the coinage of the realm. After three months she resigned in favour of her husband, el Moe'zz Aibek, a Memlouk general whom she (herself a Turkish slave) had espoused.

The people however at first refused to acknowledge a sultán who was not of the house of Aiyúb and obliged him to associate his name in the government with that of

10. El Melek el Ashraf Músá, A.D. 1250—1254.

But Aibek ultimately succeeded in deposing his partner and in obtaining undivided possession of the sovereignty. With El Ashraf ended the Aiyúbite or Kurdish dynasty after a brilliant period of eighty-one years.

ASTRONOMICAL NOTES FOR NOVEMBER.

BY W. T. LYNN, B.A., F.R.A.S.,

Of the Royal Observatory, Greenwich.

VENUS will, this month, be a beautiful object in the early evening; setting, on the first day, at 6h. 18m.; but remaining above the horizon gradually later, and, on the last day of the month, not setting until 7h. 6m., or 3 hours 12 minutes after the Sun.

JUPITER will be on the meridian at midnight on the 4th and at 11 o'clock on the 18th. The following table contains, as usual those phenomena of his satellites which will be observable before midnight. The shadow is now on the other side of the planet, and the eclipses take place a short distance from him to the right hand as seen in an inverting telescope.

DAY.	SATELLITE.	PHENOMENON.	MEAN TIME. h.	m.
Nov. 3.....	II.....	Transit, ingress	11	3
„ 5.....	II.....	Eclipse, disappearance ...	5	53
„ 5.....	II.....	Occultation, reappearance	8	16
„ 6.....	I.....	Eclipse, disappearance ...	9	21
„ 6.....	I.....	Occultation, reappearance	11	32
„ 7.....	I.....	Transit, ingress	6	40
„ 7.....	I.....	Transit, egress.....	8	50
„ 8.....	I.....	Occultation, reappearance	5	58
„ 8.....	III.....	Transit, ingress	7	2
„ 8.....	III.....	Transit, egress.....	8	38
„ 12.....	II.....	Occultation, disappearance	8	14
„ 12.....	II.....	Eclipse, reappearance.....	10	44
„ 13.....	I.....	Occultation, disappearance	11	5
„ 14.....	I.....	Transit, ingress	8	23
„ 14.....	I.....	Transit, egress.....	10	34
„ 15.....	I.....	Occultation, disappearance	5	31
„ 15.....	I.....	Eclipse, reappearance.....	7	52
„ 15.....	III.....	Transit, ingress	10	16
„ 15.....	III.....	Transit, egress.....	11	56
„ 19.....	II.....	Occultation, disappearance	10	27
„ 21.....	II.....	Transit, egress.....	6	57
„ 21.....	I.....	Transit, ingress	10	7
„ 22.....	I.....	Occultation, disappearance	7	15
„ 22.....	I.....	Eclipse, reappearance.....	9	48
„ 23.....	I.....	Transit, egress.....	6	44
„ 26.....	III.....	Eclipse, disappearance ...	4	53
„ 26.....	III.....	Eclipse, reappearance.....	6	41
„ 28.....	II.....	Transit, ingress	6	58
„ 28.....	II.....	Transit, egress	9	15
„ 28.....	I.....	Transit, ingress	11	51
„ 29.....	I.....	Occultation, disappearance	9	0
„ 29.....	I.....	Eclipse, reappearance.....	11	43
„ 30.....	II.....	Eclipse, reappearance.....	5	13
„ 30.....	I.....	Transit, ingress	6	17
„ 30.....	I.....	Transit, egress	8	28

THE MOON.—The Moon is New at 11h. 36m. on the night of the 3rd; in First Quarter at 4 minutes before three on the morning of the 11th; and Full at 18 minutes past 7 on that of the

19th. The craters Langrenus, Vendelinus, and Petavius, proceeding from near the Moon's most westerly point towards the south, and Endymion, near her most northerly visible point, may be well seen on or near the terminator on the 7th. On the night of the 8th, Posidonius will come into view; the boundary on that side of the Mare Serenitatis, which, owing chiefly to the exertions of Mr. Birt and the interest excited in the small crater Linné, is now by far the best known part of the lunar surface. The whole of that Mare may be seen on the 9th; and on the 10th, the grand craters in the centre of the Moon, Hipparchus and his neighbours, will repay examination. Archimedes, towards the north point, and afterwards Plato (now an object of much interest) nearly between it and that point, may be studied on the 11th. The next day Copernicus will deserve most attention. Aristarchus will be near the terminator on the 14th.

Several occultations of stars by the Moon will take place this month, of which we select the most interesting in the following tabular arrangement:—

DAY.	STAR.	MAG.	DISAPPEARANCE.		REAPPEARANCE.	
			MEAN TIME.	V.	MEAN TIME.	V.
			h. m.	°	h. m.	°
Nov. 10	30 Capricorni ...	6	7 11	63	7 49	9
„ 17	μ Ceti	4	9 49	99	11 10	305
„ 21	ψ^4 Orionis	5	6 52	79	7 44	225
„ 22	ζ^2 Geminorum...	4	8 51	74	9 46	215

The angle V represents the angular distance from the Moon's vertex at which the disappearance or reappearance takes place, measured towards the right hand in an inverting telescope.

THE NOVEMBER METEORS.—The Earth will pass through the orbit of these bodies (the Leonides, as they are sometimes called, from the well-established place of the radiant) an hour or two after dark on the evening of the 13th. The brightness of the Moon will be sufficient to interfere with the visibility of small meteors. Nor is there any reason to expect that the part of the stream which we shall pass through this year will be a thick or abundant one. Nevertheless the observation of these bodies is now a recognized part of the regular duty of astronomers, to whose science they are universally admitted to belong. Mons. Le Verrier has organized a

French expedition to watch for them at four different places on the shore of the Mediterranean Sea—Perpignan or Narbonne, Montpellier, Marseilles, and Nice. It is hoped that the Italians will observe at the neighbouring station of Genoa, on the same coast. Doubtless the German observers will look out with their usual diligence; nor will our countrymen be left out in the endeavour again to add something to our knowledge of these interesting bodies. It must be recollected that Leo does not rise until about midnight, so that in this part of the world the radiant point itself will be below the horizon when we are in the principal portion of the stream.

Since writing the above, we have read Mr. Proctor's highly interesting paper in last month's number of THE STUDENT. It will have been seen that he thinks it probable that the display this year may be longer in duration than it was last, in consequence of a greater spreading out of the meteors composing the part of the stream which we shall on this occasion pass through. It is admitted, however, that the question of the formation of the ring and its connection with the comet in whose orbit it moves, is so difficult, that it is by no means possible at present to build up anything like a satisfactory theory. We should imagine, if the meteors were particles of the comet left behind it, that those particles would be such as were least able to overcome the resisting force of that medium which we have every reason to suppose permeates every part of the solar system, and whose effects have been traced in the motions of Encke's comet. But it is difficult to reconcile this with the solidity which appears to appertain to the meteors. One thing we may perhaps remark in this connection; if the meteors really are parts of the comet, the motion of which is checked and retarded by a resisting medium, the parts of the stream which are at a considerable distance from the comet, must yield more to the attraction of the Sun, and gradually approach nearer to him. In that case we should encounter these some considerable time before being on the actual line of the comet's orbit. It becomes, therefore, interesting to notice whether the stream observed this year commences to be seen much earlier than the calculated time, and it will be desirable to keep up a watch on the nights of both the 11th and 12th as well as 13th of the present month. Mr. Proctor suggests that some force other than gravitation may have to be called in to account for the first formation of the meteoric ring. Perhaps when close observation has been maintained upon the November meteors during a whole orbital revolution, or thirty-three years, the know-

ledge thus acquired of the whole extent of the ring will enable astronomers to arrive at a theory which will be able to connect all the facts known concerning them. We incline to the opinion that the principal part of the display visible this year in this country will be seen in the early morning of the 13th.

D'ARREST'S PERIODICAL COMET.—Monsieur Leveau has just published a complete ephemeris of this comet, taking into account the perturbations produced by all the planets upon it. It is well known how considerably Jupiter has affected the comet's motion; about the present time the Earth and Venus are also producing sensible effects. Early in the month of May next, the comet's brightness will, according to Leveau's calculations, be as great as when it was last seen in January, 1858. It will be in perihelion about September 23, 1870; nearest the Earth in the middle of August; and of greatest apparent brightness about the beginning of September.*

Although this comet is not likely to be visible until the spring, yet we may avail ourselves of this opportunity to give some account of its previous history.

It was discovered by Dr. D'Arrest (now Director of the Copenhagen Observatory) at Leipzig,† on the 27th of June, 1851, in the constellation Pisces; it was even then excessively faint. Early in July it was observed by Dr. R. Luther, at Berlin, and by Professor Argelander, at Bonn, being in perihelion on the 8th of that month. As the distance from the Earth was afterwards also increasing, the comet did not improve in brightness. It was, however, subsequently observed by Father Secchi at Rome, by Mr. Carrington at Durham, by Mr. Ferguson at Washington, and by Dr. Wichmann at Königsberg. Observations were also carried on by Dr. Brünnow at Bilk until September 27, by Dr. Reslhuber at Kremsmünster until October 1, by Professors Challis at Cambridge and Argelander‡ at Bonn until October 4, and by Dr. Galle at Berlin until October 6. Secchi stated that even on September 1, he was able to distinguish a small nucleus, and Argelander that about that time a condensation was perceptible in the centre. Professor Challis said that it was seen in the large refractor at Cambridge so late as October 24; but the faintness was then so extreme that observation of place was impossible. Little interest would have been felt in the comet had it not been for its being found to move in an ellipse with a period

* "Astronomische Nachrichten," No. 1773.

† "Astronomische Nachrichten," No. 764; vol. xxxii., p. 327.

‡ "Astronomische Nachrichten," vol. xxxiv., p. 45. All the other observations here referred to will be found in vols. xxxii. and xxxiii. of that periodical.

of only about six years and a half. A perihelion passage was therefore predicted early in 1858, but, on account of the comet's position, it could only be then observed in the southern hemisphere. Mr. (now Sir Thomas) Maclear, and his assistant, Mr. Mann, observed it at the Cape of Good Hope from 1857, December 5, until 1858, January 18; and this series comprises the whole of the observations made at that return. Maclear stated* that, when he detected it, "all light had been excluded from the equatoreal room for some fifteen minutes, otherwise perhaps it might have escaped; and when I looked occasionally during the series of observations, the image was never brighter than at first." Mr. Mann described the comet as "a very faint nebulous body subtending a diameter of about $1\frac{1}{4}'$."

It appeared by calculation that, in March, 1861, this small body approached Jupiter within about thirty-four millions of miles, which must have caused the large mass of that planet to alter the comet's orbit considerably, and made it pass its perihelion in 1864 sooner than it otherwise would have done. At that return, however, it was too near the Sun to be seen at all. As before remarked, the period being about 2332 days, we may expect it in the course of next year; but the treat thus in store for us can hardly be a great one. The comet will, however, come much nearer us than in 1858.

The Total Eclipse of last August.—The principal observations of this eclipse which have hitherto come within our reach are those made in Iowa, under the direction of Professor Henry Morton. Some very curious observations of the corona were made by Professor Pickering,† who was attached to that party; but the conclusions to which they seem to tend can scarcely be looked upon as definite or established. In the first place he found that the light of the corona was not polarized, as it has hitherto been supposed to be, and suggests that the contrary result obtained by previous observers was owing to their mistaking the polarization of the sky for that of the corona. If this be really the case, it of course proves that the light of the corona is not produced by direct specular reflection. The spectroscopic observations showed a continuous spectrum free from dark lines, but containing two or three bright ones, and it appeared that these were really due to the corona; one at least, perhaps three, coincided with those of the aurora borealis. The dark lines may have been invisible from the

* "Monthly Notices of the Royal Astronomical Society," vol. xix., p. 45.

† "Philosophical Magazine," vol. xxxviii., p. 281.

feeble light of the corona; but, as far as the observation goes, it points to a self-luminous character as existing in this phenomenon. Some other effects noticed, particularly an increase in the actinic and heating powers of the Sun's rays as the Moon's disc approached his, led Professor Pickering to suggest the possibility of the corona being in part produced by a lunar atmosphere; a conclusion which (as he himself remarks) it is of course difficult to accept.

We look for some further observations of this eclipse, and shall also anxiously expect the information which may be obtained on future occasions of a similar kind. It is not likely that the interest of total solar eclipses will ever be exhausted, but it is certainly very far indeed from being so at present. The protuberances were well seen in America, with results confirmatory of those previously arrived at.

New Comet.—A faint comet was discovered by Herr Tempel at Marseilles on the 9th of October. Its place was R.A. 10h. 34m., N.P.D. 87° 50′, or in the constellation Sextans, on the borders of Leo.

Dr. Winnecke continued to observe at Carlsruhe the periodical comet which goes by his name, so late as until the 18th of September.

Variable Stars.—Besides S Geminorum, which is only visible in the morning hours, five of the known variable stars are expected to arrive at a maximum of brightness during the present month. One of these, S Vulpeculæ, is due about the 1st, but its total change is very small, less than a magnitude, and, its period being only sixty-eight days, its place has before been given in our "Notes." The remaining four stars are the following:—

NAME OF STAR.	R.A.	N.P.D.	PERIOD.	MAGNITUDE WHEN		DAY OF MAX.
	h. m. s.	° ′	days.	Max.	Min.	
R Scuti	18 40 30	95 51	71·7	4·7	9	Nov. 16
R Vulpeculæ.....	20 58 33	66 42	138	7·5	13	„ 20
S Delphini	20 37 2	73 23	278	8	11	„ 4
S Aquarii	22 50 5	111 3	279·4	7·7	11	„ 17

Erratum in "Notes" for last Month.—Page 222, line 21, for "29·08 days," read "22·08 days."

THE MOA OF NEW ZEALAND.

THE following is a digest of a lecture on the Moa, delivered by Mr. Mantell at the New Zealand Institute at Wellington, on the 19th September, 1868. After a few introductory remarks as to the character of the subject being too extensive to be fully treated in one lecture, raising as it did abstruse questions in comparative anatomy, geology, and archæology, as well as in the early history of the Maoris, Mr. Mantell proceeded to show that New Zealand was not alone in the circumstance that large birds without the power of flight were, previous to the arrival of the human race, the highest form of life. He then described the different circumstances under which the remains of the Moa are found, and assigned the highest antiquity to those discovered under the stalagmite in certain limestone caves, similar to the bone caves in which traces of the early animals which inhabited Great Britain are preserved to us. The difference between the British caves and those of New Zealand is that amongst the great variety of animals represented in the former, there is always sufficient proof that they were dragged into these caves by beasts of prey, while in the caves of New Zealand no such evidence exists, or, indeed, any evidence that any animal then lived beyond larger forms of those which now inhabit the islands. The bones of the Moa found in these caves, and probably also those found in alluvial deposits belong to a period before the arrival of the aborigines. The circumstances under which the Moa remains are found often associated with the works of man, leave no doubt, also, of their co-existence with the earliest aborigines and that the birds were largely used as food. An examination of the *umus* or Maori ovens gave evidence of the prevalence of cannibalism at the time the Moas were used for food, but only in the North Island. The works of art associated with bones in these early deposits indicate a period when many of the implements in common use amongst the Maories, and supposed to have been brought with them from Hawaiki were unknown to these early aborigines. The highly prized pouamu or greenstone appears also to have been discovered in New Zealand at a later date. The most ancient of these Maori ovens were probably those at Wainongara in the North Island, and Awamua in Otago; they were scooped out in the surface of marine deposits, mostly blue clays, or sands, such as those deposited in estuaries or tidal lagoons, and they were never covered by other than fresh water or blown sand deposits. The

fragments of stone used as cutting implements found in the ovens at the above named places, indicated that even at that early period the natives had extensively explored the interior of these islands, and it is highly probable that, in Otago especially, the interior was their usual dwelling place and that their visits to the sea coast were only occasional or periodical. Rude figures by early aborginal artists are sometimes seen on the walls of these caves, and in one which Mr. Mantell discovered in the Waitaki valley a rough sketch of a Moa was depicted. The extermination of the birds must have taken place within a very short period after the appearance of man, evidence of this is found in the very slight and obscure allusions in the most ancient Maori traditions.

After alluding to the probable habits and mode of life of the Moa and to the present representatives, of the class of birds to which it belonged, Mr. Mantell concluded by saying that in his lecture he confined himself to the subject of the Moa, the native word including these birds as a whole, leaving the different species of Dinornis, Talaptery, and other genera which have been made, to those who believe that they have the necessary data; for his part he did not believe that with the exception of the very fresh skeleton found at Otago, and now in the York Museum, of which the integuments and feathers are partly preserved, there was yet a single skeleton restored in such a manner, as would be at all suited to the wants of the bird if it were alive; he, therefore, strongly urged the careful collection of specimens, and that those persons who discovered bones, if they were not well acquainted with the subject, should leave them untouched until they could be exhumed by properly qualified collectors.

Dr. Hector in proposing a vote of thanks to the lecturer, said that it was highly valuable to have obtained the expression of his opinions respecting the association of the Moa with the aborigines of New Zealand, as Mr. Mantell had arrived in that country, well qualified for the task by previous training, and had enjoyed favourable opportunities as the first explorer of a large extent of the colony where these birds formerly abounded. The collections in the museums in Europe and America show how well he availed himself of those opportunities. Dr. Hector said he understood Mr. Mantell to incline to the opinion that the Moa owed its destruction to a race of aborigines different in their habits and savage attainments from the Maoris of the present day, though perhaps having the same origin; but while agreeing in this, he stated that he did not attach much importance to the alleged absence of greenstone and

other implements of an advanced stage, from the early Maori ovens; and explained how the use of chest-flakes would naturally suggest itself, as they would be abundantly formed when chest-stones were heated and quenched with water in the process of cooking according to the Maori fashion. It would seem as if when one of these flakes had a convenient shape such as a knife, cleaver, or spear-head, it was trimmed and sharpened in the same manner as a gun flint, rather than cast away when the edge became defective, and that a race advanced far beyond such rude works of art might yet find it convenient to employ them. Dr. Hector alluded to the profusion of Moa egg-shells in the ovens of the interior which showed that the eggs must have been prized as food, and that their consumption must have soon led to the extinction of the birds.

Mr. Travers remarked, with regard to the origin of the aborigines by whom the Moas were exterminated, that he considered them to be a distinct race, now represented by the Morioris of the Chatham islands. He wished more particularly to notice the important field which New Zealand offered for ethnological research; and related as a circumstance requiring explanation, that in a circular pit in the Waikato, a number of human skeletons were found in an erect position arranged round the side, each with a block of wood on its head, and he hoped that some one would investigate the matter.

CRYSTALLIZATION OF SILICA BY A DRY METHOD.*

Up to the present time, crystals of quartz have only been formed by the wet method, but the presence of this mineral in rocks, to which an igneous origin is attributed, seemed to indicate that it might be formed by the dry method. M. G. Rose had already remarked that the silica which is separated in blowpipe experiments with salt of phosphorus, does not belong to the amorphous modification, for it is insoluble in caustic potash; but it occurs in crystals so small that he found it impossible to determine their form under the microscope. Now, however, he has repeated his experiments on a much larger scale, fusing silicic acid in crucibles in the presence of different fluxes in a porcelain furnace, and he has succeeded in showing that,

* Paper communicated to the Berlin Academy; also described in "Archives des Sciences," Oct., 1869, from which we translate.

under these circumstances, it crystallizes in small hexagonal plates having a density of from 2,311 to 2,317.

This density, the form of the crystals, and their habitual methods of grouping, prove that under these conditions silica crystallizes not as quartz, but under that modification, recently discovered by M. von Roth, in the trichyte of Pachuca, in Mexico, and to which this learned mineralogist gave the name of Tridymite, and which was subsequently found by Sandberger in the trachytes of Mont Dore, of Siebengebirge.

These results were obtained by fusing with salts of phosphorus adularia felspar, or amorphous silicic acid, or by melting silica with Wollastonite, or with one-third of its weight of carbonate of soda, or borax. Usually in these experiments the tridymite forms a mass of very small crystals floating on the surface of the molten glass.

Ten years ago, G. Rose noticed a notable diminution of density of silica by fusion, and often even by simple calcination. As at that time only amorphous silica was known as distinguished from quartz by inferiority of density, it was concluded from these experiments that a high temperature changed the quartz into the amorphous condition, although the density of the quartz so acted upon was about 2·3, or a little higher than that of amorphous silica, which is 2·2. Now, it may be assumed that it is really the crystalline silicic acid, but under the form of tridymite, which appears in these experiments at high temperature.

M. G. Rose does not, however, think that the formation of quartz by the dry method is impossible, and he considers it may be accomplished at a less elevated temperature, or by a much slower cooling.

It is obvious that this question has a most important bearing upon many geological problems. Investigators of silica should not forget the curious crystals obtained by Mr. Slack, by blowing small bubbles with fluo-silicic acid gas in white of egg. The solid films which are formed contain numbers of minute crystals, of which the composition is unknown.

PROGRESS OF INVENTION.

IMPERMEABLE PAPER COLLARS, CUFFS, ETC.—It is proposed to make these of paper which has been partially converted into vegetable parchment. It is well known that water has little or no effect on paper so prepared, and colours and patterns can be applied with the greatest facility.

FETTLING OR LINING PUDDLING FURNACES.—Mr. William Matthew Williams, of Sheffield, has patented the following process. It consists in fettling or lining the beds and sides of puddling furnaces with black oxide of manganese, either alone or mixed with oxide of iron, or other material. In using oxide of manganese, without admixture with other substances, it is reduced to a fine powder and moistened, so as to bring it into a plastic state, it is then applied to the bed and sides of the furnace. When it is used in combination with iron oxide, it is applied in the way in which oxide of iron is ordinarily applied. The use of manganese expedites the puddling process, and causes improvement in the quality of the steel or iron. The heated iron, or steel, during the process of puddling, decomposes the manganese peroxide, causing an evolution of oxygen, which, rising through the molten iron, rapidly oxidizes the oxidizable materials contained in it. A portion of the reduced manganese enters into alloy with the iron or steel, and effects an improvement in its quality.

PRESERVING ANIMAL AND VEGETABLE SUBSTANCES, ETC.—Mr. G. W. Perry, of Melbourne, Australia, treats the substances to be preserved as follows. They are first washed in a solution of bisulphite of lime and magnesia, and then dipped in a boiling solution of gelatine and bisulphite, and so, when dry, the substance is coated with an air-tight covering. In order to preserve animals, without removing the skin or feathers, a hot solution of bisulphite of lime and magnesia, with the addition of ten per cent. of common salt must be injected into the blood vessels as soon as the blood is drained from the body, and before the carcase has become set. The viscera may then be removed, and the inside thoroughly cleansed and washed with the bisulphite solution. Fish, to be preserved, should be cleansed, the viscera removed, and then packed in barrels, filled with a pickle composed of salt and bisulphite solution. Liquids, too, such as ale and wine, or other fermented liquors, it is said, can be preserved in vessels, the inside of which have been washed with bisulphite of lime and magnesia.

MANUFACTURE OF SULPHURIC ACID.—This invention consists in the employment of ammonia, or carbonate of ammonia, to condense the nitric acid vapours escaping from the exit of the vitriol chambers. To accomplish this, ammonia, or carbonate of ammonia, is caused to come in contact with the escaping fumes, either in a cone tower or chamber. The fluid, thus resulting, is again afterwards decomposed with sulphuric

acid, and the escaping nitrous fumes are returned into the vitriol chamber for the oxidation of the sulphurous acid. The patentee of this invention is Mr. Konrad Walter, Wicklow, Ireland.

ACID PROOF CEMENT FOR CORKS.—If corks are soaked for two or three hours in silicate of soda, and allowed to dry, and are then covered by a cement made of silicate of soda and finely powdered glass, they are found to resist the action of acids, even boiling nitric acid, for a long time. It is recommended to use the cement for lining chemical apparatus.

TREATING COD LIVER OIL, ETC.—In this invention, carbonic acid gas, either in the gaseous form, or dissolved in water, is employed. To sweeten oils and fatty substances, the rancid material is worked over into a vessel charged with either carbonic acid gas, or carbonated water. The vessel is then sealed up, and atmospheric air is excluded. Milk, butter, and other substances can be preserved in the same way. Milk is condensed by any of the usual processes, and is then charged with carbonic acid gas in an air-tight vessel. Butter, too, can be made to be always sweet, if the churn containing the milk and cream be charged with carbonic acid during the operation of churning, and if the butter be stored in vessels in an atmosphere of carbonic acid, or in water charged with carbonic acid. The inventor of these processes is Mr. Thaddeus Hyatt, of New York.

TREATING CORN FOR PANIFICATION.—By this process corn is prepared for bread-making without grinding, and it is asserted, that by it, all the nutritious portions of the grain are retained, and only the outer pellicle is removed. The corn is first steeped in water to remove dust and foreign matter; in this way defective grains can be removed, as they will be found floating on the surface. After steeping for half an hour, the water is to be run off, and the grain is introduced into a metal cylinder with rasp-like projections on its inner side, which remove the outer pellicle. The grain is then placed in a receptacle filled with water, at 68° Fahr., about 400 lbs. of water being employed to about 200 lbs. of grain, so that there may be a certain quantity of water above the grain, about 2 lbs. of semi-dried yeast, and from ·15 lb. to ·2 lb. of glucose having been previously mixed with the water, this fermentable matter acts by degrees upon the grain, which, after about twenty or twenty-four hours immersion, is ready for fermentation as bread, having absorbed from fifty to seventy per cent. of water. The water is then drawn off, and the grain is placed in a hopper, which, by means of a distributor, causes it to pass between rollers, where it is reduced to a pasty condition. The pasty mass is then mixed with water, to which the requisite amount of salt has been added, and the dough is then made up into loaves and baked.

A NEW SWEETMEAT.—It is often amusing to notice the very simple and ordinary matters which are sometimes made the subject of a patent, the following is one of them. M. François Arond, of Lyons, has pro-

visionally patented a method of manufacturing a *veritable* sweetmeat. He mixes seven ounces of sugar, one ounce of marmalade, eleven drams of rum or other spirit, eleven drams of extract of *meat*. After thorough incoporation, the sweetmeats are moulded, dried, and finally candied.

Apparatus for Cooking.—This apparatus consists of a vessel, having a jacket or inner lining of tin, or other proper metal. The jacket has a nozzle or lip, and being filled with water, is placed on the fire; by this means the inner space or compartment of the jacketed vessel is heated with dry heat, and so adapted as to receive a partially roasted joint of meat, or any other substance requiring to be completely cooked. The whole of this apparatus is enclosed in a vessel which is covered with some substance which is a bad conductor of heat, and is termed by the inventor a heat retainer. By this combination a great saving of heating material is effected, and the meat is never rendered hard, as is often the case in the ordinary methods of cooking.

Umbrella and Dress Suspender.—Messrs. McDougall and Eden, of Manchester, have invented an umbrella and dress suspender. It is made in the following manner: A piece of elastic cord, rather longer than would be required for a dress suspender merely, is employed; the ends are connected in any suitable manner, when it is placed round the waist. A metal plate is then provided in which eight holes are pierced in a line, and near to each other. The elastic cord is then passed backward and forward through these holes alternately, leaving a loop of the same between the two centre holes. This loop forms the umbrella suspender and may be lengthened or shortened by drawing the elastic cord through the holes. A button or tassel is attached to the loop, for facility of drawing out or expanding the loop when the umbrella is removed from it.

Hydraulic Cement, or Artificial Stone.—This invention consists in the production of a hydraulic cement, which may be white or tinted, and which perfectly resists the action of water, and is suitable for ornamental purposes for the decoration of buildings. The principal components of this compound are lime, silica, and alumina, the two latter being extracted from refractory clays. In order to bring about the formation of the double silicate of lime and alumina, sulphuric and boracic acid are added in small quantities. The proportions of the constituents are varied as the cement is required to set slowly or more quickly. For producing the cements the substances in an anhydrous state are employed in the following proportions:—

Fat lime of first quality	67·956	to	74·6555	per cent. by weight.
Refractory clay . . .	27·182	to	42·889	ditto
Sulphate of lime . . .	4·757	to	9·055	ditto
Boracic acid	0·105	to	0·401	ditto

The cements formed between these limits vary in the rapidity with which they set, but are of equal quality, and attain in the course of time the same degree of hardness. The substances are mixed after being ground to a fine powder, they are then made into bricks with water, and are baked at a white heat; after this they are reduced to an impalpable powder. This powder, mixed with water, is then used as the cement, either plain or coloured, and can be moulded as required. The inventor is M. Jules Antoine Dubus, of Paris.

Ventilating Apparatus.—The body of the ventilator consists of a wedge-shaped box, attached to a supporting frame or diaphragm, which is intended to secure the body to the window. When double-windows are used, a funnel is provided which can be removed at pleasure. The body is fitted with a perforated shelf for holding a sponge or other porous absorbent, and is provided with a perforated box holding charcoal. This box is made to fit tightly into the top of the body, and can be removed at pleasure. The ventilator is also provided with a sliding valve for regulating the supply of air. The method of using the ventilator is to place it in the window in lieu of a pane of glass, as high up as possible; when double windows are used, the funnel must be placed in the corresponding pane of the outer window. When the external air is damp, the sponge should be placed on the perforated shelf, and should the wind blow strongly, the regulator should be made use of to moderate the quantity of air admitted. The external air, which is always more or less in motion, is conducted to the body of the ventilator, and impinges on its inclined side. It is this deflected upward through the perforated shelf, the sponge, and the charcoal box, and is drawn into the room to supply the place of the warm light air passing through the foul air escape pipe, provided for that purpose. Owing to the construction of the ventilator, the fresh air so passing in is directed upwards and inwards, there is therefore no sensible draught. It also enters the room divided into small streams, like water from a rose, so that it is perfectly distributed. Dr. Henry Howard, of St. John's, Canada, is the inventor.

Apparatus for Sounding Tuning Forks.—Mr. Harry Jones, of Duchess Street, Portland Place, has invented an instrument for sounding tuning forks, and he declares the object of his invention to be, to provide the tuning fork, whether common, chromatic, sostenenti, or otherwise, with a case or sounding board adapted and attached to the same, and also to provide means by which the tuning fork may be struck and sounded whilst it still remains attached to the sounding board or case. Thus by this invention a musical note may be sounded with certainty by an instrument which may be held in the pocket, or otherwise kept out of sight and without applying it to a table or board. For the purpose of effecting this, a sheath is used, into which the tuning fork is fitted, the fork ends remaining free to vibrate, and near the end openings are made in the sheath, and a striker is fitted (usually radiated with four radii, two

remaining within and two protruding beyond the sheath). The striker being pressed by the thumb or finger, strikes the end of the tuning fork, which then emits the musical sound. If thought desirable, several forks can be placed together in one case.

CEMENT FOR PIPE JOINTS.—An improved cement is made by mixing with three hundred parts, by weight, of Portland cement, or other hydraulic cement, about one hundred parts of iron turnings or filings, or any oxide of iron reduced to powder, and about one part of ammonium chloride, with about two parts of sulphur. The ferruginous refuse of sulphur copper ores may be substituted for the iron turnings. The cement is made up with water, and sets rapidly after being rammed in, whilst it can be easily removed by a chipping tool when required.

PURIFYING AND STORING WATER.—Mr. Frederick Lipscombe describes his invention as follows:—I place inside a cistern a filter, and cause the impure water to pass through the filtering media, and from it, to flow through supply pipes to the house. The filter has in its lower part a chamber, through which, by means of an aperture the unfiltered water flows, finding a exit through another aperture, then to any convenient part of the house. The top side of the chamber is perforated with holes, through which the unfiltered water in the chamber flows upwards through the filtering media, which is composed of animal and vegetable charcoal, plates of porous stone or other material, thence the purified water is drawn off directly for use, or may be stored in a reservoir. By reversing the current of water the filter may be cleansed.

REFRIGERATORS.—This invention consists in the arrangement of one coil of pipe within another and larger coil. The pipes are made of metal. A stream of water is made to pass through the outer tube, and the liquid to be cooled is passed through the inner and smaller tube; it is preferred to cause the two liquids to flow in different directions. This refrigerator is an adaptation of Liebig's condenser, and is precisely the same as one described by Mr. F. S. Barff in "The Laboratory," with this exception, that his was made of glass, the two tubes being bent together whilst separated by a layer of finely powdered chalk.

PHOTOGRAPHS.—Mr. Oliver Sarony, of Scarborough, has discovered a method of making photographs resemble sepia drawings. He takes a small negative portrait and enlarges it by sun or artificial light, he prefers to use Solomon's magnesium enlarging apparatus. He thus prepares an enlarged transparent picture, which he places on a rough surfaced paper, on which has been printed by means of lithography hatched lines, or tinted shading or softening back ground, the transparent picture being so arranged on the glass as to fall in a suitable position for the lithographic shading or hatching to blend into and with the softened outline of the photographic picture. The transparent picture on the glass with the lithographed paper backing is then mounted and framed in the usual way.

APPARATUS FOR PRODUCING ELECTRIC LIGHT.—The light is produced by a rapid succession of sparks, due to successive charges and discharges of a condenser charged directly from a voltaic battery, without the intervention of any induction coil. When this apparatus is used for a beacon light, the condenser is on the beacon, and the battery on shore is connected with a terminal on the beacon by a submerged cable or aerial wire. The condenser is charged and discharged by a tongue or contact maker moving backwards and forwards between the battery terminal and an earth terminal. The motion of the tongue may be produced by clockwork driven by a spring, which might be wound up in some cases by the motion of the buoy or beacon, as self-winding watches are wound, or it might be produced by currents sent from shore through a second wire, which would move the tongue by an electro-magnet. As the tongue of a relay is moved by the usual Morse instruments. In order to prevent the contacts, when the sparks pass, from wearing away too rapidly, the contact pieces may be made to revolve slowly, so as to distribute the action over a large surface. When the invention is used in connection with buoys or beacons, it is not essential that the condenser and contact maker should be on the beacon, as the spark can be sent through a considerable length, even of a submerged cable. The spark may be also made to spring across a partial vacuum. The inventor is Mr. Fleming Jenkin, of Edinburgh.

LITERARY NOTICES.

AN INTRODUCTION TO THE SCIENCE OF HEAT: Designed for the use of Schools and Candidates for University Matriculation Examinations. By Temple Augustus Orme, Teacher of Chemistry and Experimental Physics, University College School, London. (Groombridge and Sons.)—The progress which has been made of late years in the study and explanation of the phenomenon of heat has rendered all the older works on the subject more or less out of date, and unfit for school teaching or private study. Professor Tyndall's "Heat as a Mode of Motion," is a model work of its kind; and Professor Stewart has published a valuable treatise, adapted to advanced students. There was, however, no satisfactory elementary book especially devoted to this one subject, and treating it in a simple way. This want has been supplied in the carefully-prepared treatise of Mr. Orme, who has steered through the difficulties of his task with great care and success. His object has been to make the principal phenomena and laws of heat "intelligible to those who possess a fair knowledge of arithmetic and an ordinary amount of intelligence;" and we have no doubt his work will be acknowledged to be the most useful, within its limits, that has appeared. We have looked carefully through

it, with the very satisfactory result of finding it a simple and judicious exposition. It forms a companion volume to Barff's "Chemistry," which it worthily follows. We are particularly glad to notice that, with here and there an exceptional phrase, Mr. Orme's expositions are consistent with the theory of "heat as a mode of motion," and not as a distinct entity. The old facts relating to what was called "latent heat" of course remain as important as ever, but they have acquired quite a new position from discoveries relating to the correlation of forces, the mechanical theory of heat, and so forth, and Mr. Orme has taken due notice of the changes in expression that the new views demand. For "latent heat" he uses the term potential heat, which may do until we have a better; and for "specific heat" he employs the more explanatory term, relative heat. In conformity with the practice of all our best scientific men, he employs the metric system; and it is to be hoped that before long the vexatious and cumbrous English weights and measures will be entirely abandoned in all civilized transactions or computations. As soon as one branch of his subject is completed, Mr. Orme gives a table of examples, to which answers are appended. The questions are such as an intelligent examiner would put, and, together with the answers, will be found a valuable help.

The Scenery of England and Wales, its Character and Origin: being an attempt to trace the nature of the geological causes, especially Denudation, by which the physical features of the country have been produced. Founded on the result of many years' personal observations, and illustrated by eighty-six woodcuts, including sections and views of scenery from original sketches, or from photographs. By D. Mackintosh, F.G.S., author of papers on Denudation, in the "Quarterly Journal of the Geological Society," "Geological Magazine," "Intellectual Observer," etc. (Longmans.)—It would require a very long notice to do justice to this book, as it not only deals with difficult questions, but with a great number of cases of geological action, all more or less open to dispute. Mr. Mackintosh is already favourably known to our readers as a good observer, and a pleasant guide to scenes which add scientific interest to pictorial beauty, and we feel no doubt we shall secure a considerable circulation for the present work by stating the nature of its contents. In the first book, Mr. Mackintosh discourses of the connection between denudation, upheaval, lines of fault, etc., and enters at some length into the theories of denudation, with frequent reference to illustrative localities within easy reach of ordinary tourists. The second book illustrates the denuding action of tidal currents, the origin of the sea-coast scenery, and of the inland scenery of England and Wales; after which come, in the third book, a series of Excursions, twenty in number, and to a variety of remarkably interesting places. It is obvious that such a book, written in a pleasant style, and possessing a considerable degree of scientific merit, will be a valuable aid to intelligent tourists,

and will greatly enhance the pleasure they may derive from their trips. To some of Mr. Mackintosh's statements we should demur, such as "that all formations present the same types of scenery"—an assertion, however, soon contradicted by the author's own explanations; and we think there must have been a slip of the pen when "escarpments" are said to be "terraces on a large scale." Every terrace must have an escarpment, but escarpments, or steep slopes, are not necessarily connected with terraces. Mr. Mackintosh is a skilful draughtsman, and the numerous illustrations he has given add much to the value of his book.

ELEMENTS OF CHEMISTRY, THEORETICAL AND PRACTICAL. By William Allen Miller, M.D., D.C.L., LL.D., Treasurer and Vice-President of the Royal Society, Vice-President of the Chemical Society, Professor of Chemistry in King's College, London, Fellow of the University of London, Hon. Fellow of King's College. Fourth edition, with additions. Part III. Organic Chemistry. (Longmans.)—The third volume of Dr. Miller's well-known "Elements of Chemistry" is extended in the present edition to 976 pages, and contains a vast amount of information, together with a good index—a thing of great value in a scientific work. We shall not be thought uncourteous to Dr. Miller, or as underrating his arduous labours, if we say that his "Elements" will be valued more for their abundant and miscellaneous information than as exponents of chemical theory. The general nature of the contents of this third volume are too well known to require explanation. In the fourth edition they are substantially the same as in earlier editions, but with important additions and alterations required by the present state of science. The metrical system of weights and measures is adopted throughout, concurrently with our own clumsy system. This is a good plan, as it will be some years before our weights and measures can be entirely dispensed with in works intended for general use. It is a pity that any students of the present day, commencing their career, should be plagued with the old system, but when from long habit associations have been formed with it, the best thing to do is to introduce the metrical system as Professor Miller has done.

THE SCHOOL ARITHMETIC, formerly called "Arithmetic for Beginners." By James Cornwell, Ph.D., and Joshua G. Fitch, M.A., author of "Science of Arithmetic," "Key to School Arithmetic," etc. Tenth edition. (Simpkin and Co.)

THE SCIENCE OF ARITHMETIC: A Systematic Course of Numerical Reasoning and Computation, with very Numerous Exercises. By James Cornwell, Ph.D., and Joshua G. Fitch, M.A. Twelfth edition. (Simpkin and Co.)—No one who looks over these books can doubt their merit. They are both founded upon the principle of giving clear, intelligible explanations of arithmetical processes and numerical relations. Under old forms of teaching, pupils are dreadfully plagued with arithmetic, with the exception of those who have a natural gift for

calculation, which they can exercise without understanding. By the method of Dr. Cornwell and Mr. Fitch, the reasons for what is done, as well as the method of doing it, are plainly set forth, and the pupil is judiciously led to find them out for himself. The chapters on fractions afford good illustrations of these facts. Fractions are usually made sad stumbling-blocks, but in these books the difficulties are removed in a very satisfactory way. Other portions appear to us equally commendable.

The Spirit Controversy: Letters and Disputations on the Human Spirit and Soul; their Nature and their Condition both here and hereafter; with Remarks upon Future Rewards and Punishments. By Daniel Biddle. (Williams and Norgate.)—We have uniformly declined to do more than mention books of a theological character, anything like a critical examination of them being beyond our sphere. The title sufficiently indicates the nature of Mr. Biddle's speculations and disquisitions, which relate to subjects of great interest, and are treated by him scripturally rather than scientifically.

The Floral World and Garden Guide. Edited by Shirley Hibberd, Esq., F.R.H.S. October. (Groombridge and Sons.)—The illustrated article in this number relates to the Allamandas, a coloured engraving being given of *A. nobilis*, a handsome gold-coloured plant. The "culture of the Cactus" is likely to be increased by a useful paper on that subject. Other articles refer to new Azaleas, Solanums for winter decoration, etc.

An Elementary Course of Theoretical and Applied Mechanics, designed for the use of Schools, Colleges, and Candidates for University and other Examinations. By Richard Wormell, M.A., B.Sc., Medallist in Mathematics and Natural Philosophy, London. (Groombridge and Sons.)—This forms one of the series of Science Manuals commenced by Barff's "Chemistry," and to which Orme's "Heat" belongs, and which promise to become standard works in our principal schools. Mr. Wormell's treatise, though only extending to 338 pages, including the index, supplies three graduated courses of study; the first adapted to the requirements for matriculation at the University of London; the second answering to the curriculum for the First B.Sc. and preliminary scientific examinations; and the third, the Second B.A. and B.Sc. course. Mr. Wormell has shown considerable skill in condensing his explanations without damaging their simplicity, and at the end of his chapters useful "exercises" will be found, with the answers attached. The entire arrangement of the work adapts it to students who will have to undergo examination. They can easily find any passage required for reference; and the "exercises" afford an excellent key to the kind of questions they may expect. Abundant illustrations, diagrams, and drawings are given; and we have no hesitation in predicting that the work will be approved both by teachers and scholars.

NOTES AND MEMORANDA.

MICRO-FERMENTS IN BLOOD.—MM. Bechamp and Estor affirm that what is called the fibrin of the blood is only "a false membrane formed by micro-ferments associated together by a substance they secrete with the help of the albuminous constituents of the liquid." They state that in the blood of all the animals they have examined (dog, cat, ox, rabbit, and reptiles) they find an infinite number of mobile molecular granulations, which have all the character of micro-ferments, and resemble those found in the cells of the liver, but smaller and more transparent. After acting on starch or sugar, and their transformation into chaplets of from two to twenty granulations, they are positively insoluble in acetic acid and in potash, "*au dixième*." In "defebrinated blood" it is found that almost all of these bodies have disappeared, and the small quantity of fibrin afforded by the blood of little kittens, which is favourable for the observation, looks, under the microscope, like thin strips of the "mother of vinegar," finely granulated; and these micro-ferments transform themselves into chaplets, or bacteriums. The experimenters receive the blood in water slightly kreosoted, to "annihilate external influences," as they phrase it. They separate the fibrin by beating, and wash it in a current of water, to which kreosote-water is frequently added. When the fibrin was thoroughly washed, they placed it in four phials; 1, containing kreosoted starch; 2, the same, with carbonate of lime added to the boiling liquid; 3, cane sugar, dissolved at the boiling point of the liquid, and kreosoted; 4, the same, with carbonate of lime. The phials were hermetically sealed, and kept at a temperature of from 25° to 35°. The fibrin became fluid, and the micro-ferments exhibited what the authors call intermediate forms between the ferments and bacteria.—"Comptes Rendus."

SPECTRA OF GASES UNDER HIGH PRESSURE.—The "Archives des Sciences" (No. 141) gives an account of experiments by M. Wüllner on this subject, from which it appears that the spectrum of one and the same gas rendered incandescent by the electric spark, varies considerably according to temperature and pressure. Hydrogen exhibits four very distinct spectra, one with six groups of green lines, that of Plücker, with three brilliant rays; the continuous spectrum with two of these three rays, $H\alpha$ and $H\beta$, and the absolutely continuous one obtained under high pressures. Oxygen shows four spectra, at 10^{mm} pressure; 1, at the last limits of pressure a spectrum of the second class, composed of five groups of brilliant lines in the green and blue; 2, at 1^{mm}, and below, a continuous spectrum composed of broad bands, especially in the green and blue; 3, at about 10^{mm} a spectrum of the second class, described by Plücker; and, 4, at high pressures, a continuous spectrum, with a great number of brilliant lines in the most refrangible part. Nitrogen gives two spectra, one continuous, but "channelled," at low pressures, and at high ones a continuous spectrum without channels, but with a great number of bright lines, at first in the green and blue, and afterwards in the red.

AIR CURRENTS AND WEATHER CHANGES.—Mr. R. H. Scott has a paper on this subject in "Proceedings of the Royal Society," 114, in which the following is the most important passage:—"Case 1. The polar current flows in a latitude higher than the equatorial current. In other words, easterly winds prevail in the north, westerly in the south; northerly and southerly winds are entirely absent. Twenty-seven instances have been recorded of these conditions, and they are very generally followed, after a brief interval, by a barometrical depression, frequently resulting in a southerly gale. In twelve instances a southerly gale followed in two days; in four in three days; in six, fresh southerly winds, not a gale, followed; in two, a north-east gale followed; in two, a southerly gale set in at once; one, no change ensued."

GASEOUS AND LIQUID STATES OF MATTER.—Dr. Andrews (Bakerian Lecture, "Proceedings of the Royal Society," 114, states, "from carbonic acid as a perfect gas to carbonic

acid as a perfect liquid, the transition may be accomplished by a continuous process, and the gas and liquid are only distant stages of a long series of continuous physical changes."

Action of Chloroform on Insects.—Mr. Slack writes;—"A few weeks ago I took some honey from hives with the aid of chloroform to stupify the bees, thinking that if the quantity administered was small the insects would soon recover. I did not succeed in hitting the happy mean, if there be one, either the bees were not rendered stupid enough, or they remained so long insensible as to seem dead, and most of them did not recover. Supposing a pan full to be dead, they were left in the garden all night, and in the morning their numbers were considerably diminished. It was thought that some had revived under the stimulus of the morning's warmth and light, as they had been looked at occasionally for two or three hours at night without any motion being detected. In a second case stupified bees were placed under shelter in an arbour, and with a pan over them during the night. Many of them woke up about eighteen hours after they had been chloroformed, but seemed very feeble, and did not seem to recognize the way into their hive, the lower part of which had not been disturbed. In some experiments on the amount of chloroforming insects would stand, and recover from, a blue-bottle was held close to a wet stopper, and in a few seconds became insensible. In a minute or two he recovered animation, and spun swiftly round and round on his back like a teetotum, until he died. I did not see this in any second instance. It probably arose from a particular ganglion being affected."

Deep Sea Dredgings.—In an abstract of a paper in the "Proceedings of the Royal Society," 114, Dr. Carpenter observes, "That reduction in the size of Foraminifera cannot be attributed to increase of pressure, since the examples of *Cornuspira*, *Biloculina*, and *Cristellaria* found at depths exceeding 500 fathoms, were far larger than any known to exist in the shallower waters of the colder temperate zone. But as all these occurred in the *warm area* whose bottom temperature indicates a movement of water from the equatorial towards the polar regions, it is probable that this size is related to the *temperature* of their habitat."

The Æpyornis of Madagascar.—MM. Alp. Milne-Edwards and Alf. Grandidier describe in *Comptes Rendus*, 11th Oct. 1869, certain curious anatomical peculiarities of the bones of the Æpyornis, and they observe "that it belongs to a group of shortwinged birds, but constitutes amongst them a type characterized by its massive forms, and by feet of a size difficult to conceive. It must be placed beside the dinornis and apteryx, although it is removed from them by important features of its organization, and by the pneumaticity of its thigh bones. The height of this bird was much less than J. Geoffroy St. Hilaire thought. Taking the length of its foot as a basis of calculation, the Madagascar bird scarcely exceeded two metres, which is the height of a large ostrich, while the *Dinornis giganteus* varied from two and a half to three metres. But if the Æpyornis is not, as was supposed, the biggest of all these birds, it is the stoutest, the most massive, the most elephantine, if we may so express it."

TWO HORNED RHINOCEROS.—RHINOCEROS BICORNIS.
(Young Male.)

TWO HORNED RHINOCEROS.—RHINOCEROS BICORNIS.
(Young Male.)

AFRICAN RHINOCEROSES.

BY P. L. SCLATER, M.A., PH.D., F.R.S.,

Secretary to the Zoological Society of London.

(*With a Coloured Illustration.*)

On the 11th of September last year the first living African rhinoceros that has reached Europe, since the days of the Roman Amphitheatre, arrived in London. Along with a figure of this animal, as it now appears in the Gardens of the Zoological Society of London, I propose to offer to the readers of The Student, some particulars of what is known of its history, and to add some remarks upon the present state of our knowledge of the African rhinoceroses in general.

First, as regards the history of the present specimen; the first and only individual—as far as we know—that has been brought alive to Europe in modern days. It was purchased by the Zoological Society for the sum of one thousand pounds of Mr. Carl Hagenbeck, a well-known dealer in living animals at Hamburgh. Mr. Hagenbeck had bought this rhinoceros some weeks previously, along with a large collection of giraffes, African elephants, and other animals imported by Herr Casanova, of Vienna, from Eastern Africa. Herr Casanova obtained the rhinoceros from the Hamran Arabs, who inhabit the district to the south of Cassalà, in Upper Nubia; and concerning whose peculiar mode of hunting Sir Samuel Baker has told us such marvellous stories. Herr Casanova's visit to Cassalà in 1867—1868 was the last of a series of expeditions made by this enterprising traveller into that country for the purpose of obtaining collections of living animals, for the menageries of Europe. Of that of the previous season (1866—67), one of his companions, Mr. Ernest Marno, of Vienna, has published a very interesting account,* which will serve to give us some idea of the mode in which such expeditions are conducted.

The party left Trieste by the usual steamer to Alexandria, and proceeded thence to Cairo and Suez by railway. From Suez they took one of the Egyptian steamers, of the Abdul Azziz Company, down the Red Sea to Suakim. After a detention of fourteen days in this city, during which they were engaged in collecting the necessary goods and supplies, they started on the last day of December, 1866, with a caravan of thirty camels, through the terri-

* See "Der Zoologischer Garten," 1868, p. 81.

tory occupied by the Hadendowa Arabs, and in eighteen days march reached Cassalà, the chief city of the district of Taka, which Herr Casanova makes a sort of head-quarters during these expeditions. The young elephants, giraffes, and most of the other living animals brought home are procured by purchase from the Hamran Arabs, who, in the summer months, dwell on the banks of the rivers Settite and Atbara, several days journey to the south of Cassalà. After a short stay at Cassalà, Herr Marno joined the rest of his companions, who had preceded him, at the summer-quarters of the Hamran sheik, Ued Agagl, near the banks of the Settite, four days march from Cassalà, and took up his residence for two months, in a straw hut, assigned to the party by the sheik. The price given for each young African elephant when brought in, is stated to have been one hundred Maria-Theresa dollars (about £20), of which, ten dollars goes to the sheik, whilst the rest belongs to the fortunate individual who has captured it. Before they left the sheik's head-quarters, eleven elephants had been obtained in this way, and five more were subsequently bought of the Menna Arabs in the market at Cassalà; so that the party finally quitted that city on the 7th of May, with a collection of sixteen elephants, besides a large number of hyenas, lions, antelopes, and birds of various kinds. To conduct these to the sea-port at Suakim, thirty camels and forty drivers and attendants were employed. While the elephants were led by one or more attendants, the antelopes and smaller animals were packed in cases and carried on the backs of camels. But, in spite of every care, the losses met with on the route to Suakim, and subsequently on the sea-voyage, were considerable; and the collection was much diminished before it finally reached Trieste, and was there disposed of to the European dealers in living animals.

Such is an outline of Herr Casanova's expedition of 1866—7. No living rhinoceros was brought home on this occasion, although, as Herr Marno informs us, one of the Aggaggeers, or sword-hunters, captures a very young specimen, which, however, died before reaching sheik's encampment on the Settite. During the next expedition (that of 1867—8) Herr Casanova was more fortunate. A young male rhinoceros brought in by the Arabs on the 12th of February, 1868, was reared with much difficulty; and, along with a number of African elephants, giraffes, antelopes, and other animals, transported to the coast at Suakim. Hence he was carried by steam and rail to Hamburgh (via Suez, Alexandria, and Trieste), and, as I have already stated, eventually survived to reach the Zoological Society's Gardens, in the Regent's Park. In this

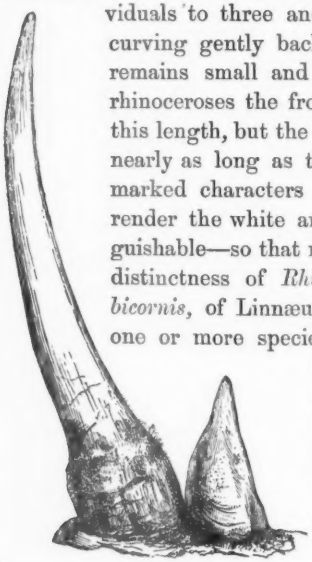
establishment he has since remained in good health, and has greatly increased in size, and improved in appearance.

"Theodore," as our African rhinoceros has been named, after his famous but illfated compatriot, is now about four feet in height, but still growing fast. He consumes daily about three quarters of a truss of the best clover hay, six quarts of oats, mixed with three pecks of bran, seven pounds weight of biscuit, and the best part of a truss of straw; so that his board costs the Society from six to seven shillings a day. He was first lodged in the giraffe-house, but on the recent completion of the new elephant-house was removed thither, and has for his companions two Indian elephants, two African elephants, two Indian rhinoceroses, and a pair of Tapirs. He is the only unmated animal in the building—a deficiency which we hope to remedy before he is quite adult.

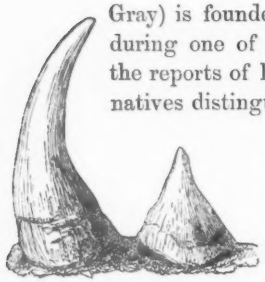
Having now given the history of our individual African rhinoceros, I must say a little about the position of this animal in the scheme of nature. In the first place it should be stated, that the genus *Rhinoceros*, which was in a former epoch of wide distribution over the world's surface, is now confined within a comparatively small area—or, I should rather say, within two widely separated areas —one of which is Asiatic and one African. The Asiatic rhinoceroses, of which three species are known to exist, form a group by themselves, easily distinguishable from their African brethren by the presence of incisor teeth, and folds on the skin. Of these animals I propose to say more on a future occasion. The African rhinoceroses, to which group the animal I have been speaking of belongs, on the contrary, have no incisor teeth when adult, and scarcely any appearance of the peculiar folds of the integument, which form such a characteristic feature in the Indian species.

The African rhinoceroses are again subdivisible into two sections —commonly known as white rhinoceroses and black rhinoceroses— from the prevailing colours of their skins; which, although by no means strictly white and black respectively, are, according to those authorities who have become acquainted with them in their native wilds, strongly contrasted in hue, and render the two varieties easily recognizable. Another trenchant difference between these forms is in the shape of the upper lip. This in the white rhinoceros is quite short and rounded, being formed for grazing, like that of a cow. From this feature, Dr. Burchell, the first scientific traveller who met with the white rhinoceros, named the animal *Rhinoceros simus*. In the black rhinoceros on the contrary, the upper lip is long and prehensile, forming a short proboscis, well fitted for

taking hold of the small branches of trees, upon which it subsists. Besides this, there is a great difference between the horns of the black and white rhinoceroses. In the white rhinoceros the front horn is enormously produced in the adult, reaching in old individuals to three and a half or four feet in length, and curving gently backwards, but the hinder horn always remains small and slightly developed. In the black rhinoceroses the front horn never attains anything like this length, but the hinder horn is longer—in some cases nearly as long as the front one. There are also well-marked characters in the bones of the cranium, which render the white and black rhinoceroses readily distinguishable—so that no doubt can remain as to the perfect distinctness of *Rhinoceros simus* from the *Rhinoceros bicornis*, of Linnæus, or black rhinoceros. But whether one or more species are not comprised under each of these two names, is a subject which admits of some argument. Dr. Gray, who has recently written a paper in the "Proceedings of the Zoological Society of London,"* on the *Rhinocerotidæ*, makes out two species of white and two species of black rhinoceros. The second species of the white form (*Rhinoceros Oswelli* of Dr. Gray) is founded upon a horn obtained by Mr. Oswell, during one of his expeditions to Lake Ngami, and upon the reports of hunters and travellers, who state that the natives distinguish the *Kobaaba*, in which the front horn is bent forward at the end, from the *Monoohoo* or *Mohoohoo*, in which it is recurved throughout. There is I think, as yet, no sufficient ground for regarding this as more than an occasional variation occuring in old individuals of *R. simus*, especially as the natives say that they have "never seen a young *Kobaaba*."



WHITE RHINOCEROS.



BLACK RHINOCEROS.

As regards the black rhinoceroses, we have much better evidence of there being possibly two species of this form, but

* "Observations on the preserved specimens and skeletons of the *Rhinocerotidæ*, in the collection of the British Museum and Royal College of Surgeons, including the descriptions of three new species." By Dr. J. E. Gray, P.Z.S. 1867, p. 1003.

neither in this case is it, I think, quite sufficient. Sir Andrew Smith was the first naturalist to discriminate a *Rhinoceros keitloa* from the Linnean *R. bicornis*, the characters chiefly relied upon being the larger size and more produced lip of the former, and the fact of the hinder horn being longer; nearly, if not quite as long as the front horn. The *Keitloa* was only met with in the far interior of the colony, near Kurrichaine, and is supposed by Sir Andrew Smith, to be the northern representative of the *Bovili* or *R. bicornis*. If this be the case, all the specimens of black rhinoceros from Natal, Zanbesia, and Eastern Africa generally, ought to belong to the *R. keitloa*, and our living animal must be referred to the same species. But I have examined many heads of rhinoceros from these countries, and have not been able to convince myself that the characters above stated, as far as they can be observed in dead specimens, are always to be relied upon. There is certainly much individual variation in the comparative length of the anterior and posterior horns of the African black rhinoceroses, and the existence of two distinct and well-marked species of this form appears to me to be not yet proved. It would, however, be very desirable that a careful comparison should be made between an authentic skull of *R. bicornis*, and the skull of the rhinoceros obtained by Mr. Jesse during the recent Abyssinian expedition, as that would go very far to solve the present question.

As regards the habits of the black rhinoceros in a state of nature, we have some interesting details given us in Sir Samuel Baker's "Nile Tributaries of Abyssinia." Sir Samuel met with this animal, on the Atbara and Settite—the same locality, whence our living individual was procured—and tells us that it is the only species of rhinoceros inhabiting that country. It is "generally five feet six inches to five feet eight inches high at the shoulder, and, although so bulky and heavily built, is extremely active. Its skin is about half the thickness of that of the hippopotamus, but of extreme toughness and closeness of texture, and when dried and polished resembles horn. . . . . It is extremely vicious, and is one of the few animals that will generally assume the offensive; it considers all creatures to be enemies, and, although it is not acute in either sight or hearing, possesses so wonderful a power of scent, that it will detect a stranger at a distance of five or six hundred yards, should the wind be favourable.

"I have observed that a rhinoceros will generally charge down upon the object that it smells, but does not see; thus, when the animal is concealed either in high grass or thick jungle, should it

scent a man who may be passing unseen to windward, it will rush down furiously upon the object it has winded, with three loud whiffs, resembling a jet of steam from a safety valve. As it is most difficult and next to impossible to kill a rhinoceros when charging, on account of the protection of the brain afforded by the horns, an unexpected charge in thick jungle is particularly unpleasant; especially when on horseback, as there is no means of escape but to rush headlong through all obstacles.

"The teeth of this animal are very peculiar. The molars have a projecting cutting edge on the exterior side; thus the jaws when closed form a pair of shears, as the projecting edges of the upper and lower rows overlap; this is a favourable arrangement of nature to enable the animal to clip off twigs, and the branches on which it feeds, as, although it does not absolutely refuse grass, this rhinoceros is decidedly a wood-eater. There are particular bushes which form a great attraction; among these is a dwarf mimosa with a reddish bark; this tree grows in thick masses, which the rhinoceros clips so closely, that it frequently resembles a quickset-hedge that has been cut by the woodman's shears. These animals are generally seen in pairs, or the male, female, and calf; the mother is very affectionate, and exceedingly watchful and savage. Although so large an animal, the cry is very insignificant, and is not unlike the harsh shrill sound of a penny trumpet. The drinking hour is about eight p.m., or two hours after sunset, at which time the rhinoceros arrives at the river from his daily retreat, which is usually about four miles in the interior. He approaches the water by regular paths made by himself, but not always by the same route; and after drinking, he generally retires to a particular spot, beneath a tree that has been visited on regular occasions; in such places large heaps of dung accumulate. The hunters take advantage of the peculiarity, and set traps in the path leading to his private retreat, but he is so extremely wary, and his power of scent is so acute, that the greatest art is necessary in setting the snare."

Sir Samuel Baker, then proceeds to describe at full length the peculiar pitfalls constructed by the Hamran Arabs, for the capture of this wily animal. They are made so that not the whole body of the rhinoceros falls into them, but only one of his feet, which thus becomes fixed in a noose, to which a log of wood is attached. The animal quits the spot dragging about after him this inconvenient companion, and thus becomes an easy prey to the experienced sword-hunter.

JEAN BODIN, AND THE HISTORY OF WITCHCRAFT.

BY HENRY WHITE, PH.D.,

Author of "History of the Massacre of St. Bartholomew," etc., etc.

Possibly there are but few readers of The Student, who have ever heard of Laurent Bordelon, and yet he was an author of some little repute at the beginning of the eighteenth century. He wrote comedies, moral essays, and novels; yet of all his works the only one that has survived the century and a half since his death, is the "Histoire des Imaginations de M. Oufle," and that not so much for its literary merits as for the engravings with which it is illustrated. The hero of the tale, after eating a hearty supper, in which the wine was not spared, strays into the bed-room of his son, who had gone to a masked ball, and there sees stretched out upon a chair, a disguise skilfully formed out of a bear-skin. This he puts on, intending to surprise his wife, but finding her engaged, he goes into his library, and while waiting takes a book from the shelves, sits down before the fire, and begins reading. The warmth and the book, superadded to the supper and the wine, draw him off to sleep. A sudden noise arouses him with a start, he springs up, catches a look at his face in the glass, and immediately imagines that he has been transformed into a bear. The freaks and follies in which he indulges while under this delusion form the substance of Bordelon's four tedious volumes. The book which produced such an effect on poor M. Oufle's imagination was the "Démonomanie" of Bodin.

Jean Bodin was born at Angers about 1530. It has been said that his mother was a Jewess, whose parents had been expelled from Spain at the close of the preceding century. This, if true, may account for a certain vein of free-thinking to be traced in all his writings. He studied the law, graduated at Toulouse, and seems for a time to have occupied himself with teaching. His dissertation "De instituenda in republica juventute" was probably nothing more than the ordinary essay composed on taking a degree. Teaching could not, however, have occupied him long, for he is hardly twenty-one years of age when we find him at Paris, trying his fortune at the bar and in chamber-practice, but gradually turning his thoughts to scientific studies. His first work was the "Methodus ad facilem historiarum cognitionem," a method of acquiring a knowledge of history. The title was a misnomer, for the book had no method in it; but it, nevertheless, contained some

good things. Bodin, like most young men, was a believer in the progress of humanity towards universal brotherhood: "Verùm etiam omnes homines secum ipsi et cum republicâ mundanâ, velut in unâ eâdemque civitate, mirabiliter conspirant." He also indulged in fascinating visions of human perfectibility: "Fallunt qui genus hominum semper deterius evadere putant."

But Bodin aimed at other prizes than the reputation of scholarship and the applause of the learned. He was ambitious and delighted in the atmosphere of courts. Henry III.—one of the vilest of the Valois monarchs—loved to talk with him, and received him at his table. Henry's brother, Alençon, who was always going to be a king but never was, made Bodin one of his councillors, and loaded him with favours. The duke was a poor half-witted prince, always needing some one of strong purpose and resolute will to guide him. Bodin was made Procureur du Roi at Laon, and in 1576 represented the Tiers Etats of Vermandois, in the States-General of Blois, where he defended without success the principle of religious toleration. He wrote a diary of what took place at the second meeting, and speaks of himself with becoming modesty. Pierre Versoris, a noisy partisan of the League, said the king was resolved that all his subjects be of one religion, namely, the religion of Rome, and had personally told him so: "à quoy le député de Vermandois dit que c'estoit l'ouverture de la guerre." Davila tells us that he was secretly advised by the king to oppose the clergy on this point. Later in the session, when Henry III. asked for two million ducats to carry on the war against such as refused to conform to the state religion, Bodin protested against the vote with so much force and good sense, that even the clergy supported him, their fear of being taxed being greater than their hatred of heresy. He was evidently the leader of the "peace party," for at the very last moment we find him proposing another attempt to bring back the wandering sheep to the true fold, "sans bruit et sans aucun désordre de guerre." The motion was debated for two days and carried at last.

If Bodin's career had terminated at this point, he would have left behind him the reputation of an advanced thinker, a man of noble and generous thoughts, a lover of his fellow-citizens. But the meeting of the States-General of Blois was the turning-point of his life. He had opposed the League, but to keep his post at Laon, he went over to their side. He sacrificed the great cause of peace and religious liberty for mere personal aggrandisement.

In 1577, he published his "Six livres de la République;"

in which he advocated a monarchical government as being in accordance with the nature of things: "si naturam propius inspiciamus, monarchiam ubique intueri licebit;" and declared that states were constituted "non libertatis causâ sed benè vivendi." In the nineteenth century we do not understand how there can be any living well without liberty, but three hundred years ago society wanted a strong master. The work was dedicated to Dufaur de Pibrac, the judge who disgraced his office by defending the St. Bartholomew massacre.

In two works, published respectively in 1568 and 1578, Bodin refuted the economical paradoxes of M. de Malestroit. The treatises are valuable contributions to the history of political economy, as showing what glimpses the earlier writers had of the fundamental principles of that science, and how little they profited by them. Bodin saw that the value of the precious metals depended upon supply and demand, that the rise in prices had been caused by the great influx of gold from America, and that if the trade between foreign nations were free, wars would be less frequent. That he was not faithful to his principles, and defended protection as a legitimate means of revenue is not extraordinary, considering how inconsequent some writers and statesmen are, even in the nineteenth century.

Another book written about this time, but not published until 1857 is the "Colloquium heptaplomeres de rerum sublimium arcanis abditis"—a dialogue between seven persons: a deist, a secularist, a Jew, a Zwinglian, a Lutheran, a Romanist, and a Mahometan. It is hard to find out what the opinions of the writer are, but his conclusion is a favourable index of his toleration. After discussing their respective religions, and the philosophic doctrines involved in them, the disputants each retain their own convictions, continuing to live peaceably together, doing good, cultivating the sciences, and honouring God: "Nullam postea de religionibus disputationem habuerunt, tametsi suam quisque religionem summâ vitæ sanctitate tueretur." In another place he says: "Religionem imperare non possumus, quia nemo cogi potest ut credat invitus." It is easy to understand why the "Colloquy" was not printed during the author's lifetime.

But the book by which Bodin will be always most known is the "Démonomanie des Sorciers," published in 1578. During the sixteenth century the belief in witchcraft was universal. The devil was an actual entity, a real visible palpable personage, roaming about the world in search of victims, whom he generally found

among the poor, old, and ignorant. There is a certain grain of superstition in every human heart, but three hundred years ago that grain had grown up into a huge tree, casting a foul shadow over everything. Even our age, which has seen the prodigies of witchcraft surpassed by the wonders of photography, the steam-engine, and the electric telegraph, can hardly afford to look with contemptuous pity upon the sixteenth century, when there are still so many believers in the follies of spiritualism. A witch riding through the air upon a broom is just as credible and as possible as Mr. Home "elongating" as if he were made of india-rubber, or floating out of one window and in at another. The only difference is that in old times witches were cruelly tortured and burnt to death, while modern sorcerers make a good living out of their dupes. The form is changed, the substance is the same.

Bodin's treatise was suggested by a curious trial at which he was present as a spectator. In 1578, one Jeanne Hervilliers was accused of witchcraft, her mother having been burnt alive for the same crime thirty years before. Jeanne confessed that she had been dedicated to the devil from her birth; that at the early age of twelve she had had illicit intercourse with a demon; and that for thirty years she had received the embraces of an incubus, even when lying by her husband's side. She further accused herself of several murders, and though these crimes had not been committed, for the murdered persons were still alive, she was condemned to be burnt, and eagerly courted death. Bodin tells us that all were agreed that she deserved to die, but that some thought hanging would be severe enough—which opinion he did not share. His book was written (he says in his preface) to demonstrate that sorcery was the most detestable of crimes, and "partly also to answer those, who in printed books, endeavour to save witches by every means, so that it would appear as if they were inspired by Satan." He then quotes examples of persons who, for maintaining that sorcery was an imaginary crime, had been regarded as tools of the Evil One, and had been condemned to death as guilty of the very offence whose existence they had denied.

It is a question how far Bodin was a believer in witchcraft, or whether he did not write his "Démonomanie" in order to avert the suspicions which his free-thinking seem to have brought on him. Guy Patin writes in one of his letters: "Bodin's 'Démonomanie' is good for nothing. He did not believe in it, and only wrote the book that the world might believe he believed in it, inasmuch as he was suspected of atheism because he favoured the Huguenots." But it was

hardly necessary to write a book of more than 600 folio pages for such a purpose, and if we examine it we shall find it as intolerant, as bigoted, as cruel, as if it had been written by an inquisitor-general. The first chapter of the fourth book, "De l' inquisition des Sorciers," he sums up with this villainous maxim : "Tout cela est licite en droit divin et en droit humain, quoique S. Augustin, au livre *De Mendacio* et S. Thomas d' Aquin soient d'avis qu'il ne faut jamais mentir de huit sortes de mensonges, qu'ils mettent bien au long ; mais les juges ne suivent pas ces résolutions." Bodin does not teach the judges how to investigate the facts in order to arrive at the truth ; he looks upon every accused person as guilty, and considers that the magistrates' only aim should be to extort a confession by means however foul. Conformity with facts is of no value ; a confession is true when it coincides with the foregone conclusions of the judge. Bodin especially recommends the questioning of children against their parents, and that the witnesses should be kept in prison, and be half-starved, frightened, and even tortured, until they confessed what the judge wanted to know. Johann Weyer, better known, perhaps, by his Latin name, Piscinarius, wrote two works, in which he ventured to ascribe the delusions and manifestations of witchcraft to the pathological condition of the sufferer, who was rather the victim than the accomplice of the devil. According to the science of the day, he endeavoured to account for certain facts regarded as supernatural, and exhorted the Emperor of Germany to spare the blood of the innocent, who were more to be pitied than punished. Bodin denounced the author and the books as alike worthy of the fire.

One feels a grim sort of satisfaction on learning that Bodin, notwithstanding his book, did not escape an accusation of magical practices. The "Démonomanie," with other of his writings, had been condemned by the Roman Inquisition, "jure optimo," says Del Rio, for it was crammed with errors, and contained "multis noxia, et quæ ambiguam auctoris fidem satis contestantur, nocereque legentibus possent." Bodin was acquitted, but he would hardly have been so fortunate had the mode of procedure been adopted towards himself which he recommended against others. In 1596 he died, his last work being the "Universæ naturæ Theatrum," in which he combated very laboriously and illogically the Copernican ideas of the daily and yearly revolutions of the earth. He began life as an independent thinker, he ended it as the slavish defender of the grossest superstitions. He was not the stuff out of which martyrs are made. His "Démonomanie" was translated into Latin,

and became a text-book on the subject, and we may add that it caused as much suffering as any book since the revival of learning.

In the sixteenth century witchcraft and demoniacal possession were accepted facts. Certain physical and psychical phenomena could not be explained, and what so easy as to ascribe them to Satan. The Church supported this view, and pointed to the Witch of Endor and the miracle of the swine. Diabolical possession, the compact with the Evil One, and the orgies of the Sabbath, the three most striking characteristics of witchcraft, were a new outgrowth of the human imagination. There was nothing like them in Pagan antiquity, although there was a strong belief in magic: Egypt and the far East knew nothing of them. They were the produce of the Middle Ages, growing as naturally out of the intellectual darkness of the times as a foul parasitic vegetation springs up in dark, damp, unventilated cellars. And the clergy did nothing to reform this state of things, but stoutly maintained the ugly superstition, and were the last to throw it off. It is no excuse for the Church to say that its ministers were but men, and not worse than their worshippers; they ought to have been better, for they possessed all the learning of the age, claimed to be the superiors of the laity, and had at their head a man who asserted himself the vice-gerent of God. Let the blame fall where it is due. The clergy fostered every kind of superstition not merely because they were themselves ignorant, but because they were wise enough to foresee that as soon as the laity became enlightened the extravagant powers of their corporation would be taken away.

Michelet in his melodramic book entitled "La Sorcière," shows, after his fantastic manner, how witchcraft gradually grew up during the dark ages of European history; how it was fed by the misery and isolation of the people; how like leprosy it grew in the fetid hovels of the poor, and was kindled into life by the grotesque and hideous legends which was all the religious food given them by the clergy. Just as some of the most beautiful fictions of the Pagan Mythology owed their origin to the shadows of the clouds flitting across the mountains, to the whisperings of the woods and to the music of the brooks as they danced along to the sea; so the gloomy mythology of witchcraft sprung up in the gloomy forests and dreary moors of our northern lands. As was natural, Satanism began with the women; it was a matter of temperament. From the witch of Endor to Circe and Medea, from the Delphic Pythonesses to the silly girls whose hysteric ravings founded the sect of the Irvingites, from the crones of Macbeth to the mediums of the spiritists, and

the fortune-tellers who haunt our kitchens—women have always had (or been supposed to have) a stronger connection with the supernatural than the other sex. Sprenger, no mean authority on such a matter, writes: "We must say the heresy of the *witches*, not of the wizards, for the latter are of no consequence." Bodin and De Lancre are of the same opinion. And the records of the courts of justice bear them out, for the women accused of sorcery are tenfold —nay a hundredfold more numerous than the men. "Pour un sorcier, dix milles sorcières," says the proverb. De Lancre gives a very offensive reason for this supposed fact. He agrees with Bodin, "Que ce n'est pas pour la foiblesse et fragilité du sexe, puisqu'on voit qu'elles souffrent la torture plus constamment que les hommes. [Women have always been the firmest of martyrs.] Ce seroit donc plus tôt la force de la cupidité bestiale que pousse et réduict la femme à des extrémitez esquelles elle se jette volontiers pour jouir de ses appetits, pour se venger, ou pour autres nouveautez et curiositez qui se voyent esdictes assemblées [the Sabbath], qui a meu aucuns philosophes de mettre la femme entre l'homme et la beste brute." Against a charge of sorcery, neither beauty nor youth was any protection: indeed, for reasons which may be divined, they were often aggravations of the offence. Hauber, in his "Acta et Scripta Magica," gives a list of 157 persons executed at Wurtzburg for sorcery, from January, 1627, to February, 1629. It includes children of twelve, eleven, ten, and nine years of age, two boys of noble birth, the two little sons (söhnlein) of a senator, a strange boy, a blind girl, and Gobel Babelin, the handsomest girl in Wurtzburg—

Sanguine placarunt deos et virgine cæsa.

The great witchcraft epidemic of the sixteenth century broke out among the nuns of a convent at Hoorn, in Flanders. They were suddenly awoke by strange cries at night; they felt a singular tickling in the soles of their feet; they lost all power of voluntary motion, some springing convulsively in the air and falling like logs to the floor, while others climbed the trees in the garden and crawled down head-foremost. These manifestations (in which we may conclude there was at least a little trickery on the part of some of the patients) began at the close of Lent, during which the sisters had lived very sparingly on a coarse vegetable diet. Such a simple explanation was not suited to the times, and the disorder was laid at the door of an inoffensive woman of the neighbourhood, who was tortured to death. This demonomania lasted for three

years, while at the convent of St. Bridget of Lille, a similar hysterical disorder continued for ten years. In this latter case, it was satisfactorily traced to a sister who had taken the veil after being crossed in love. The nuns of Kintorp, near Strasburg, were seized with strange convulsions, during which they bit themselves or their companions. Two years later (1554) fourscore Jewish girls, who had been converted and were kept in a convent at Rome, were seized with extraordinary convulsions; and the following year seventy girls in the orphan's hospital became "demoniacs" in one night, and continued so for two years, notwithstanding that they were living in the very centre of Christendom. In other instances, all occurring within the course of ten years, the disorder showed itself in a form, in which all the modesty of the sex was trampled under foot. In these and similar demonopathic stories we must make due allowance for the credulity of the witnessess, who often saw more with their imagination than with their eyes.

It is curious to observe how the number of demonopathists increased in proportion to the severity of the persecution. Boguet, a famous judge and witch-finder, calculates that the sorcerers would form an army as large as that of Xerxes. He speaks of their "swarming" in Germany; of villages dispeopled in Switzerland; of thousand after thousand of gibbets in Lorraine; while in France they go in thousands and multiply like caterpillars. Could I have my way, he says: "je désirerais qu'ils fussent tous mis en un seul corps, pour les faire brûler tout á une fois en un seul feu." Even at the end of the seventeenth century, faith in witchcraft was still strong. In 1675 the parliament of Rouen, one of the most enlightened in the kingdom, presented a remonstrance or petition to Louis XIV., who, of his sovereign authority, had exempted several sorcerers from the stake. They prayed that "pious" monarch to support the ancient jurisprudence and not to compromise by any weakness the infallibility of justice. Among other cases, they appealed to that of 1608, against Rousseau and Piley, for malice and worship of the devil at their Sabbath, under the figure of a he-goat, which the accused had confessed; the decree of 4th February, 1615, against one Leclerc who was condemned for being present at a Sabbath, and who confessed (as well as his two accomplices, who died in prison), the presence of the tall man in black, the worship of the goat, the illicit copulations, the sacrifices, the renunciation of the chrism and baptism, and the dances dos-à-dos. The sentences of the parliament of Toulouse in 1557, against four hundred persons accused of this crime, and all marked

with a spot insensible to pain; and of the parliament of Provence in 1511.

This was written in 1675, and to show how hard-lived is every form of superstition, the French Academy had been already thirty years in existence, and Molière had produced his Misanthrope and Tartuffe." Neither literature nor theology had any power against witchcraft. It was vanquished solely by the progress of physical science. Galileo and Bacon did more to banish sorcery than all the philosophers who had ever lived. Even the great apostle of the modern spiritists will not exhibit his tricks before the students of natural science. But we must not be unjust to the seventeenth century, for here and there was found a man who protested against the reigning superstition. In 1625, Gabriel Naude wrote his apology for the great men accused of magic, which created so much alarm among the magistracy, that it could not be printed in France. That curious writer Cyrano de Bergerac in his posthumous "Lettres sur les Sorciers," denied with true Gascon impudence, the facts ascribed to them, and called the records of their trials, "fools' gazettes." But the work that did most good was written by Frederick Spée, a German, and a Jesuit priest. During his ministrations it had frequently been his painful duty to be present at the last moments of a great number of pretended witches, who spoke to him with confidence and sincerity, and convinced him of their innocence. "I affirm upon my oath," he said, "that I have never attended a single woman to the stake, whom I could safely describe as guilty. Two theologians have told me the same, and yet I took every pains to arrive at the truth." Spée did not dispute the possibility of witchcraft; but undertook to show that the sentences were based on falsehoods, and that the mode of procedure was barbarous and vicious. "Give me," he said, "the unlimited power the judges possess, of sending people to prison, of torturing them, of disregarding their means of justification, of circulating rumours to their disadvantage, and I would undertake to convict even the judges of sorcery." Balthasar Bekker, a Dutchmam, next took up the defence of the witches. He not only denied the power of Satan, but his existence. "If there be a devil," he said, "he will avenge himself for my attacks upon him." The argument is not logically conclusive, but it was so practically, for his brother ministers took Satan's part and expelled Bekker. Gradually the world began to have a meaner opinion of the devil's power—began to be incredulous about the obscene mysteries of the "Sabbath;" and as the trials for witchcraft became less frequent, the crime itself disappeared,—

slowly indeed, for the last sorcerer was burnt at Bordeaux, in 1718. Demonomania was henceforth looked upon as a disease, and the pretended witches was treated as fools or knaves. "Our brains are no longer mere store-houses for devils to dance in;" said one writer, and if the influence of the great enemy is still as active as before, on earth, in the shape of evil passions, he at least keeps personally in the background. In 1826, the clergy of Spire refused to officiate at the funeral of their bishop, because "he was suspected to be a sorcerer."

Was there any objective truth in witchcraft? To a certain extent there was. It is very possible that a knowledge of the peculiar virtues of certain herbs may have been handed down from age to age, and that the old crones, uprooting mandrake, or gathering belladonna by moon-light, may have known more of the powers of those plants than the rest of their little community. It is so even now to some extent. The philters and the poisons were realities, and one single instance is quoted by Michelet, in his "History of France," of the power of an over-dose of datura. A decoction was given to a man and his wife by some person who wished to rob their house. It produced so strange a delirium, that the unfortunate victims threw off their clothes and danced all night naked in a church-yard. Gassendi, to enlighten some poor wretches who thought they were wizards, anointed them with a pomatum containing opium, assuring them it would make them be present at the "Sabbath." They fell asleep, and, on awaking, gave an account of what they had seen at the meeting, and of the pleasures they had shared.

In England and Scotland the superstition was quite as deep, and lasted as long as in France and Germany. The statute of James I. cap. 12, passed while Coke was Attorney-General, and Bacon a member of the Commons, was not repealed until the reign of George II. During the sitting of the Long Parliament, three thousand victims perished. In 1664, the upright Sir Matthew Hale, passed sentence of death on two poor women, on evidence which a child would now be disposed to laugh at. Sir Thomas Brown, so quick to detect "Vulgar Errors" in others, was examined as a witness on the trial, and gave his opinion that the fits, under which the patients had laboured, though natural in themselves, were "heightened by the devil co-operating with the malice of the witches, at whose instance he did the villanies!" In 1716, a Mrs. Hicks and her daughter aged nine, were hanged at Huntingdon, for selling their souls to the devil, and raising a storm by pulling off their stockings

and making a lather of soap. This closed the catalogue of judicial murders in England, but the popular belief in witchcraft has by no means ceased. In 1825, the "sink or swim" ordeal was put in practice at Wickham Keith in Suffolk; and it is barely twelve-months since a poor crippled half-witted woman escaped with her life from this trial by water.

> Some only for not being drowned,
> And some for sitting above ground,
> Whole days and nights upon their breeches,
> And feeling pain, were hanged for witches.

Scotland was always notorious for her superstitions. From the earliest period of her annals, "all was bot gaistis and eldrich phantasie." Yet witchcraft appears to have been unknown until after the Reformation. The ninth parliament of Queen Mary, has the credit of passing the first statute against witches, or consulters with witches. Witchcraft became fashionable, among the adepts being Lady Buccleugh of Branxholm, the Countess of Athol, the Countess of Huntly, the Countess of Lothian, the Countess of Angus, Lady Ker, and others. Even John Knox was accused of attempting to raise "some sanctes" in St. Andrew's churchyard; but in the course of this resuscitation up started the devil himself, having a huge pair of horns on his head, at which terrible sight Knox's servant went mad with fear, and died shortly after. The first burning took place in 1572, and the last in 1722. In this case the victim was a poor old woman. "Being brought out for execution, and the weather proving very severe, she sat composedly warming herself by the fire, while the other instruments of death were made ready." In a little more than ten years later, the penal statutes were repealed; yet in 1743 we find some Presbyterian Seceders enumerating among the national sins, the repeal of those enactments as "contrary to the express laws of God!"

I shall not attempt to draw a moral from the history of this singular delusion. It serves to show the danger of encouraging those enthusiastic conceits of the possibility of direct spiritual influence, which in one shape or another, even in this nineteenth century of ours, are found to haunt the brain of the weak and presumptuous. The same principle lies at the bottom of the hallucinations of the witches, as in the quietism of a Bourignon, the reveries of Madame Guyon, and the dreams of Swedenborg. The great French pietist, who became so abstracted, that she was insensible to everything that went on around her, even to the liberties taken with her person, was first cousin to Bessie

Dunlop, who used to receive visits from "an honest weel elderlie man, gray bairdit, wha had ane gray coitt with Lumbard sleeves of the old fassoun, ane pair of gray brekis, quhyte schankis gartanit aboue the kne." This strange individual came once into the room where her husband and three tailors were sitting. He took her by the apron and led her to the kiln-end, where she saw eight women and four men sitting; the men in gentlemen's clothing and the women with plaids round about them "very seemly to see." They said to her: "Welcome, Bessie, wilt thou go with us?" but as she made no answer, they disappeared of a sudden, and "a hideous ugly sough of wind followed them." It would be well if all our modern superstitions were to be swept away with such a sough!

THE RAISED BEACHES AND SUBMERGED FORESTS OF BARNSTAPLE BAY.

BY TOWNSHEND M. HALL, F.G.S., ETC.

EVIDENCES of the successive changes of level to which the British Isles have been subjected are, at all times, of importance to the geologist; since they are the records of a distribution of land and water in former ages of the earth's history, very different to that which exists at present. They form also to the student of physical geography a series of the most suggestive problems. The botanist and zoologist, alike, recognize in the upheaval of the land, connecting links which account for the migration of species, and they enable the historian to trace, step by step, indications of the antiquity of the human race.

In this varied field of inquiry it is the interest, as well as the object of all to arrive at some chronological estimate regarding these great changes, and to tabulate, if possible, the order of their succession. It is true that the study of an isolated example of a raised beach, or of a submerged forest, may not unfrequently lead to erroneous results in calculating the exact number of feet which the land has been upheaved in the one case, or depressed in the other, whilst it is even possible that raised beaches, situated at different levels, and which have therefore been looked upon as of different ages may, in some cases, be contemporaneous. The reason of this apparent anomaly will, on consideration, be manifest. The structure of a modern sea-beach is such that it inclines

upwards from low-water mark, till it reaches the extreme limits of the waves at high spring-tides, or during storms—a range which varies immensely along the British shores; but which may be set down as at eighteen feet in the entrance of the Bristol Channel, about thirty feet in Barnstaple Bay, and fifty feet at Chepstow.

The angle of the slope of the beach would be dependent on the tide action, on the conformation of the ground, and on the nature of the material of which the beach was composed—mud, sand, gravel, pebbles, or boulders. If such a beach were elevated above reach of the sea, it would retain the same angle of slope which it possessed at the time it was last left dry by the receding waves; but supposing the coast-line to be in any degree steep, and to consist of a soft rock, the base of this uplifted beach will speedily be washed away, and its appearance would then induce any observer to believe that the land had been elevated to a greater extent than it was in reality. If, on the contrary, the line of the coast is flat, and follows much the same slope as that of the upheaved beach, then the waves will be unable to exert the same amount of influence in wasting away the lower portions of the beach, and so reducing its apparent thickness. These two examples, if they occurred along the same shore, might be regarded as affording proof of the elevation of the land at two distinct periods, since the beaches would apparently be situated at different heights above the sea-level. The one which had been reduced in thickness from the destruction of its base being considered as at a greater elevation than that which remained in all its integrity and at its full thickness.

It may be stated, then, as a general proposition, that the present level of a raised beach is dependent, not only on the extent of its upheaval, but also, to a certain degree, on the amount of waste which the coast line has undergone subsequent to its elevation. When we have the good fortune to find, in any one locality, evidences of elevation and depression in close proximity to each other, we should take every opportunity of investigating them, with a view to ascertain whether we may not be able to decide the order in which these changes took place; our estimate being founded upon an actual sequence of deposits, and not on a dubious series of measurements which might, possibly, represent nothing more than the relative waste of the coast.

At Westward Ho! on the shore of Barnstaple Bay, there may be seen within the area of a few hundred yards a raised beach, a submarine forest, and a fine example of a pebble ridge, showing within the smallest possible space three distinct and well-defined

periods—elevation, depression, and modern action. If there are difficulties in obtaining even an approximate chronology of the first two periods, still we may be able to advance one step, and prove their order of succession.

Westward Ho! is a name which has scarcely yet had time to make its appearance in any Directory or Gazetteer, and it is useless to look for it on the now antiquated map of the Ordnance Survey, published just sixty years ago. Before entering upon any description of its geological features, it may therefore be necessary to say something as to the geographical situation of a place which is likely, in the course of time, to take a prominent position amongst the watering-places of the West of England.

In any legal document, Westward Ho! might be described as situated in the parish of Northam, in the hundred of Hartland, and in the county of Devon; but for geological purposes it will be sufficient to say that it is about three miles from the town of Bideford, which at present is the furthest point a traveller can proceed westward by the London and South-western Railway.

To the contortions of the Palæozoic rocks North Devon owes its beautiful and varied scenery, but it is not the object of the present paper to describe these older formations, further than to say that the southern shore of the bay on which Westward Ho! is built consists of the grits and shales of the carboniferous series, whilst on the opposite, or north side, there are the thick series of slates and shales, sandstones and limestones, which extend from Lynton to Barnstaple, and which have given rise to so much discussion. To give even an outline of the controversy relating to these rocks would occupy several pages. After a careful study of their fossils, we believe them to be neither true Devonian or true carboniferous, in the ordinary acceptance of these terms, but a separate type, peculiar to the locality, and holding an intermediate position between the two great systems.

Spread out to the right of Westward Ho!, is the delta of the united rivers Taw and Torridge. The first of these running forty-eight miles from its source at Okement Hill, on Dartmoor, and the latter taking its rise at the Ditchen Hills, near Clovelly, a point nine miles from its estuary in a straight line, but fifty-three miles if measured along the course of the stream. The delta is bounded both on the north and south by chains of hills; in shape it is an almost equilateral triangle, each side of which is about five miles and a half in length.

The whole of this comparatively flat space is divided by the

river into two parts, and these differ most completely one from the other, not only in general appearance, but also in the manner in which they are defended from the sea. The Braunton Burrows, as the larger portion on the north side of the estuary is called, consists principally of a series of hillocks of blown sand. These continue down to high-water mark, and then gradually flatten out into a sandy beach. The southern and smaller part of the delta, is the level grassy plain which stretches out immediately in front of Westward Ho !. Northam Burrows, or "The Burrows," as they are more commonly called, are very slightly raised above the level of high tides; but they have for their sea boundary one of the finest examples of a natural breakwater which it is possible to find along the British coast. For a length of nearly two miles a ridge of pebbles rises to a height of twenty-one feet above the sand, and with a breadth of 160 feet in the widest part, it is well calculated to withstand the enormous waves which break in upon it with the whole force of the Atlantic, during some of our autumnal and winter storms. The pebbles are composed of an intensely hard and close-grained blue carboniferous grit, which is frequently intersected by quartz veins. In size they vary from two inches to thirty-nine inches in diameter; the average being, however, from seven to ten inches. After a heavy gale, small rivulets of blue mud may sometimes be noticed trickling down along the base of the ridge. These arise from the continual pounding, and from the wear and tear to which, at such times, the pebbles are subjected. To supply the deficiency caused by the reduction in their size, a more or less constant supply of new material in its rough state is brought by the waves, to be formed and shaped, smoothed and rounded. This supply is principally derived from the cliffs near Clovelly and Hartland; but pebbles of the same character may be traced for upwards of six and thirty miles along the coast, the whole way to St. Ginnis, in North Cornwall, although they are nowhere grouped in such quantities, or arranged in so perfect and symmetrical a manner as they are on the Northam ridge.

From the lofty cliffs of carboniferous grit which form the southern shores of the bay, masses of stone are continually falling, and as these, owing to the arrangement of their joints and cleavage planes, break almost uniformly into rhombohedrons, the first step, so to speak, in the manufacture of a pebble has already commenced. These rough blocks of stone are next carried by the action of the waves along the coast, at the base of the almost perpendicular

cliffs, until, in course of time, they arrive at the comparatively level shores of the delta, and are landed on the ridge. Still they preserve distinct evidence of their origin, as shown by their rhombohedral form, but, after being subjected to a few storms, they lose all traces of angles and edges, and become as smooth and oval as any of the rest of the pebbles which compose the ridge. As a further proof of the existence of this strong current along the coast, it may be mentioned that blocks of stone into which the fishermen of Hartland are accustomed to insert iron rings for the purpose of mooring their boats, have occasionally been lost during a rough sea, and, sometime afterwards, have been discovered thrown up on the Northam ridge. The smaller pebbles, of hornblende, granite, porphyry, and trap, which are frequently washed up, have travelled in all probability from the granite island of Lundy, or rather, perhaps, from some of the outlying reefs along the bed of the sea. The ridge, which was formerly one mile and a quarter in length, has been gradually extending itself during the last few years in a north-easterly direction. This is partly due to the strong sweep of the waves round Rock's Nose, but in some measure also to the fact that the sand, the peat, and the clay at the base of the ridge have been washed away to the extent of about four feet. Hence, with an increased depth of water, the waves have gained an increased power of transporting the stones.

One of the old Devonshire historians, who wrote nearly two centuries and a half ago, thus quaintly refers to the pebble ridge in his description of the parish of Northam:—"On the north-west Northam hath a large plain shelf, whereon, with some winds, the sea beats with a cruel and forcible rage, and rolleth in great stones . . . . and I observed in this place a great pile of stones, globe-wise and round. . . . . These are all great, far above the height of any ordnance; and, if I may guess, I should think these stones not naturally round, but rather by their forcible rolling with the unresistible force of the waves, the roaring noise whereof is heard far into the inland, serving as a prognostication to the inhabitants, for thereby is foretold fair and foul weather."

Our next step takes us below the pebble ridge. The peat beds which are here seen at low-water contain the roots and portions of the trunks of large trees—evidence, in fact, that there formerly existed a forest of no small extent.

It was discovered by the writer for the first time in the winter of 1864; and, after a heavy westerly gale in the January following, he counted the stems of between seventy and eighty large trees,

broken off at a height of about two feet above the peat bed, but standing in the upright position in which they grew.

This fact is of extreme importance, as many persons, unwilling, perhaps, to believe that the land has ever subsided, would wish the peat bed to be considered simply as an accumulation of vegetable matter, debris either washed up by the waves, or washed down by the river. On the occasion referred to, there was one stem of an oak-tree, which I selected for examination. It measured six feet in circumference. The bark was still perfect, and the rings of growth were well defined, although the wood was as black, and very nearly as soft, as the peat with which it was surrounded. Portions of it which could then easily be cut with a spade, have now become so intensely hard from exposure to the air, that it is difficult work to make any impression on them with a hatchet.

Much of this submerged forest has already disappeared; some of it has been destroyed by man's work, and some of it by the action of the waves; but a large portion, no doubt, still lies buried under the sand, and, if we may judge from patches uncovered two or three years ago, in digging the foundations for a house at Croyde, on the opposite side of the estuary, and also at Chivenor, further up the delta, there is every reason to suppose that the whole of these parts were formerly covered with forest. In what period this was, it is impossible to say with certainty, nor is there any history to assist us. No author previous to the year 1864 ever mentioned the existence of the Northam peat-bed; and the only indication that it was ever seen or known in historic times is afforded by a somewhat vague tradition, formerly related by the old inhabitants of the neighbouring village of Braunton, that the oak timber used for the roof and seats of their church, grew where the burrows and sand-hills now are, and that the trees, when felled, were drawn to their destination by rein-deer. Local traditions have generally a certain amount of truth at their foundation; but, in this instance, the subsidence of the land, and consequent destruction of the forest, must have taken place at a period so remote, that the only possible explanation which can be given of the origin of the tradition is, that the peat bed, with its trunks of trees and vegetable remains, must have been seen in former times by the early inhabitants of this district, who thenceforth came to the conclusion that a wood had previously existed on this spot; and the circumstance was then handed down to posterity, connected with a fragment of some other legend of the locality, relative to the employment of deer, as beasts of burden. The latter part of the story is not easily explainable;

but, as a singular coincidence, must be mentioned the fact that both the horns and bones of the red deer are found in the submerged forest, lying amongst the roots of the trees, and associated with flint flakes and chippings, accumulations of oyster-shells, calcined flints, flint cores, pointed stakes of wood, and other proofs of human handiwork.

It must be remembered that, as the peat bed at Westward Ho! slopes gradually down from the pebble ridge to low-water mark, and even extends for some little distance beneath the sea, there must have been a subsidence in the land to an extent equal, at the very least, to the present range of spring tides. If, therefore, the lowest part of the forest is covered at high tide with thirty feet of water, it follows that, at the time these trees were growing, the land must of necessity have been thirty feet higher than it is at present; whilst a still further elevation of from five to ten feet would be required in order to raise the roots above water, and so allow of the growth of the trees.

It has often been objected, and not without some reason, that, supposing the land to be elevated back again to its former level, it would still be impossible for trees to grow in such a locality, exposed, as they would be, to the full sweep of the westerly wind; and it has been suggested that the pebble ridge was formerly situated at some point beyond and outside the forest, and that the trees grew under the shelter it afforded. It is hardly necessary to say, however, that the subsidence of the land along the shores of this bay is only one out of a multitude of similar proofs of the changes of level to which the British Isles have been subjected. The sinking of the land was not a mere local occurrence, but one which extended along the whole of our coasts. In the west, there are submerged forests at Porlock and Torbay, St. Michael's Mount and Falmouth, all presenting very similar characteristics; whilst the remains of trees found in the peat of Orkney, or on the high table lands of Aberdeen and Forfar, show that in these northern districts, and not only in the West of England, forests grew in situations where, under present conditions, they would be unable to exist.

As regards the structure of the peat bed at Northam, it may not be out of place to say a few words. The largest tree of which remains have been found is the oak. The birch was of a smaller size, and the hazel grew in the greatest abundance. Hazel nuts are found in large numbers, whilst the surface of the ground appears to have been covered in some places with moss, and in

others with a species of iris or rush. There are also, occasionally, portions of the stem of a large grass, which by some chemical change have been converted into sulphuret of iron, and now present the appearance of hollow tubes of metal. Besides mammalian bones and teeth, the only traces of the existence of animal life I have hitherto met with, are the elytra of a small beetle, apparently one of the *Buprestidæ*, which resemble those found in the submarine forest of Mount's Bay, inasmuch as when first exhumed they present the most beautiful shining colours, though after a short exposure to the air, they become black, and then crumble away to dust.

The submerged forest rests generally on a thin stratum of angular fragments of carboniferous grit, which may be compared both as regards size and shape to stones broken for "macadamizing" a road. These in their turn overlie a deposit of tenacious clay, containing shells of *Scorbiculariæ;* and in places where the peat bed has been denuded, the roots of some of the larger trees are still to be traced, in consequence of their having penetrated the upper surface of the clay. A section recently made by Mr. Whitley, about sixty-six feet behind the pebble ridge, showed a thickness of no less than eight feet of pure blue clay, covered with four feet of sand and soil.

Before leaving the forest bed, one word of caution must be given, with reference to the remains of elephants, the teeth and tusks of which have occasionally been dug up in this locality. Some years ago a molar was found embedded in the mud, and it was immediately looked upon as affording a good proof of the vast antiquity of the river deposits. They were given, in fact, an age equal to that of the clay deposits near Barnstaple, where elephant remains have been found in a brick field. A great number of tusks (one of them weighs thirty-six pounds) have recently been obtained from the sand and mud outside the ridge; but the question regarding their antiquity is set at rest by the *un*fortunate circumstance that they bear certain trade marks, proving that they formed part of the cargo of a vessel which was wrecked here about sixty years ago.

Caution No. 2 is as follows:—Small circular pieces of a substance resembling jet have occasionally been found during the last few months in close proximity to the peat bed, but instead of being the beads or ornaments of a pre-historic age, they are simply water-worn fragments of cannel coal, derived from the wreck of a vessel, bound from Glasgow to Fiume, in the winter of 1868.

Leaving the forest bed, and the evidences of subsidence, we have now to consider the proofs of a former elevation of the coast line. The raised beach, or pebble ridge, which runs along the southern shore of Barnstaple Bay, commences a few hundred yards beyond Westward Ho! Hotel, and continues along the coast until it is cut off by the higher and more perpendicular cliffs, between Rock's Nose and Cornborough.

This ancient deposit is of considerable thickness, and the pebbles composing it are identical in shape and composition with those on the modern ridge. In one respect only is there any difference to be observed, and that is the earthy stain, with which the older pebbles are externally coated. This is derived from the "heading" or soil overlying the raised beach, which has been washed down through the interstices left between the pebbles.

The coast line between Westward Ho! and Rock's Nose is indented by a series of small bays or coves, and the promontories dividing them afford the best sections of the raised beach. In one of the first of these coves, the pebbles rest on a bed of siliceous sand, about two feet in thickness, whilst over them is a "head" or deposit consisting of ten feet of soil, with angular fragments of stone, brought down from the hill which rises up above it.

In the next cove the sand bed still continues, but in several places it is converted into a soft black sandstone, the grains of which are united with a ferrugineous cement. Here, at the height of fourteen feet above high-water mark, are some of the largest pebbles at present visible along any portion of the raised beach. One of them proved, on measurement, to be twenty-six inches in length. A few yards further on, the underlying bed of sand disappears, and the pebble beach is seen at its greatest thickness, resting immediately on top of the terrace or platform of carboniferous rock, the upper surface of which everywhere presents the appearance of having been smoothed and rounded by the action of the waves. The thickness of the raised beach is variable, ranging from three to twelve feet; whilst the height of its base above the present high-water mark is from ten to seventeen feet.

On the opposite side of Barnstaple Bay the continuation of the raised beach is very conspicuous. It commences near the end of Braunton Burrows, and extends as far as Saunton Point. Here it is lost for some distance, owing to the recess formed by Croyde Bay, but it appears again near the Limekiln at Middle Borough, and thence runs on in the direction of Baggy Point. This beach is much more

sandy in its character than that on the Northam side of the bay, and in no case does it contain pebbles of such magnitude.

As it is desirable to confine this paper to the evidences of the change of level which are concentrated in the neighbourhood of Westward Ho!, I must not at present attempt to describe the various sections to be seen on the north side of the Estuary, but let us endeavour, from the materials before us, to approximate the age of the submerged forest, and of the raised beaches. In the first place, it is clear that these two deposits cannot possibly be contemporaneous, and the question remaining is, which of the two is the most ancient? Both in their turn are covered with accumulations of a later date. The forest is overlain by the pebble ridge, which, although it is quite a recent formation, when measured by the geological scale of time, is of great antiquity, when considered from a purely historical point of view. Above the raised beaches are the proofs of the slow, but long continued, subäerial action, which has brought down from the adjacent heights a mass of soil or "head," which on the Northam shore averages ten feet in thickness, whilst on the Croyde side it is upwards of ten times that depth.

If the forest is of greater age than the raised beaches, or, in other words, if the subsidence preceded the elevation, the land must have undergone a downward movement of at least fifty-seven feet; that is to say, the forty feet shown by the forest-bed, *plus* the seventeen feet indicated by the raised beach; whilst during this period of submergence, and all through the countless ages requisite for the formation of the beaches, the forest must have lain more deeply submerged by three fathoms than it is even at present. Taking its situation into account, it may be asked if any trace of it could possibly have survived an exposure for so long a duration of time to the unceasing action of the waves, and to this question we may safely reply in the negative. A further objection to the theory is also to be found in the fact, that beneath the raised beaches vegetable matter has in no instance been discovered. The submerged forest may be seen to run under the modern pebble ridge; but it is invariably absent from the base of the old upheaved beaches, which, as we have before stated, everywhere rest immediately on top of the water-worn rock terraces, smoothed and rounded by long-continued wave action.

The only other alternative is, that the raised beaches are the most ancient, and that elevation preceded the depression. If so, the upheaved land surface must have been fully forty feet higher than it is now, and the base of the raised beach would conse-

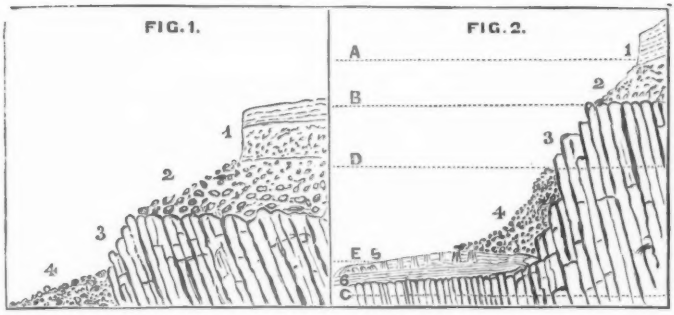
quently have stood at an height of fifty-seven feet above the sea level. During this period of elevation the forest must have grown on the alluvial soil of the delta, where, beneath the shelter of the oak and birch, man has left the traces of his handiwork. The next movement which took place in the level of the land-surface, was one of subsidence, and the destruction of the forest consequently followed. In describing the peat-beds in the previous pages, I have already given my reasons for putting the extent of this subsidence at forty feet. It may, possibly, have been more; for although there appears no proof that any reaction in the shape of another upward movement, has taken place, still such would be by no means improbable.

It will be seen that the foregoing calculations represent the very minimum amount of elevation and depression, since the measurements are taken from the high-water mark of the forestial era, to the base of the raised beach, which may be supposed to represent the mean low-water mark during the original submergence of the land. In order to arrive at the correct estimate of the change of level, to these figures must be added a certain number of feet for the tidal-range during either the raised beach or forest period, according to whichever of the two was the greatest. If the tides rose and fell to the same extent that they do at present, then twenty-eight or thirty feet would be the number to be added; but it is extremely doubtful whether the tidal-range could have been the same during the latter of these two periods, in consequence of the blocking up of so large a portion of the Bristol Channel, whilst during the former depression of the land, the tides may have been affected by the greatly increased area of the sea, which extended over the present delta of the Taw and Torridge, and up the numerous valleys which diverge from it.

The two principal conclusions to be drawn from the various phenomena, which are so well exhibited at Westward Ho! may be summed up in a very few words.

First.—The elevation of the land took place before the subsidence, and the raised beaches are consequently of greater antiquity than the forest.

Second.—The subsidence of the land, which caused the destruction of the forest, occurred at a period so remote as to be pre-historic; but there is every reason to believe that this great change of level in the coast of North Devon was subsequent to its occupation by man.



EXPLANATION OF THE ILLUSTRATION.

Fig. 1, represents a section near Westward Ho Hotel.

No. 1.—The "Head," consisting in the upper part of soil and clay, and in the lower part of the soil with angular fragments of rock.

2. Raised beach.

3. Carboniferous slate, dipping south, at a high angle.

4. Modern beach, upper portion of.

Fig. 2, is a diagram to show the relative levels of the land and sea during three successive periods.

A.—B. High and low-water mark before the elevation of the land.

C. Probable high-water line after the elevation, and during the forest period.

D.—E. High and low-water mark at the present time, after the subsidence of forty feet.

No. 1. "Head" of soil and clay.

2. Raised beach.

3. Carboniferous grits or slates.

4. Modern pebble-beach.

5. Forest bed.

6. Clay.

ASCENT OF MOUNT TONGLO, EASTERN HIMALAYAS.

BY G. E. BULGER, F.L.S., F.R.G.S., C.M.Z.S., ETC.

On Tuesday the 4th June, 1867, S—— and I left our residence on the northern side of the Darjeeling Hill, with a motley retinue of servants, guides, and coolies, *en route* for the summit of Mount Tonglo. The morning was fine but warmish, and we found the sun rather uncomfortable along the open and exposed "cart road," causing us to look forward somewhat anxiously to the shade of the forest; through which, our course would presently lie. We were accompanied by our henchman, Tempo, a most intelligent Sikkim-Bhotea, who, in addition to performing the duties of bearer to my companion, was a sort of overseer or superintendent of our gang of followers, which consisted of a Mussulman Kitmudgar from the plains, a Madras dressing boy, a Sikkim-Bhotea lad, usually employed as a sort of messenger, two Lepcha shikarees, and seven coolies—some of whom were Lepchas and some Sikkim-Bhoteas.

At "the saddle," a dip in the great mountain Sinchul, where the Jella Pahar spur unites with another running off in the direction of Tonglo, we turned our faces westward, and pursued a road leading round the southern base of the spur just mentioned, in the direction of the sources of the Balasun river, for about a mile or so; after which, striking into the forest on our right hand, we commenced ascending, by a narrow, wet and slippery foot-path, that gradually took us to the summit of the ridge scarcely wider than the track, where we travelled in single file. The two Lepcha shikarees were in front, S—— and I close behind them, and the string of coolies and followers bringing up the rear at wide intervals apart. The wonderful ability of these hill-men to carry heavy loads is so well-known, that any reference to the fact is here unnecessary; a faithful and eloquent account of them and of their powers as burden-bearers, will be found in Dr. Hooker's delightful "Himalayan Journals."

Nearly all the forests in the vicinity of Darjeeling have been, of late years, more or less thinned of their timber, and that, into which our guides led us after quitting the Balasun road, proved to be no exception; though it, apparently, had suffered less than many of the others. At all events it was dense enough, in places, to be almost impenetrable; and its enormous trees, towering to a stupendous height above us, gave token of great age, as well as of most absolute luxuriance and vigour. The whole of this sub-Himalayan forest is wonderfully peculiar and impressive; and the richness and

abundance of its vegetation was to me so amazing and unexpected, that I fairly paused in astonishment and admiration, when I first penetrated its mysterious recesses, and beheld the exuberant mass of orchids, vacciniums, ferns, mosses, lichens, and lycopodiums, which cover the giant tree-trunks and branches, the outcropping rocks of the mountain-ridges, and the very earth itself, with one superb, teeming and voluptuous robe of living emerald, relieved from all possibility of monotonous uniformity, by flowers of the rarest beauty, in almost unparalleled profusion.

As we entered the woods, a mist began to rise from the valleys below us, and we were soon enveloped in a gloomy cloud that boded rather unpleasantly for the afternoon, and rendered the dripping forest dark and somewhat chilly. Of four-footed creatures there were none to be seen—not even lizards—and birds were by no means plentiful. We, however, obtained specimens of the stripe-throated flower-pecker (*Yutrina gularis*), a gregarious little creature that affects some of the tallest trees, and is, therefore, not easily shot; and one of the orange-headed ground thrushes (*Geocichla citrina*); we also saw a pair of grey-winged blackbirds (*Merula boulboul*), and of the splendid red-billed blue magpies (*Urocissa sinensis*). These marginal woods were very silent, and, save the hollow, metalllic note of some bird, which, Tempo assured us, was, the "thing-poom" (*Glaucidium Brodiæi*), we heard no sound.

As we advanced the clouds got heavier and darker, and presently it began to rain—slightly at first, but afterwards so heavily, that we were glad to take refuge under a huge, projecting rock, at a place called the Lepcha jagah—a sort of village of herdsmen, where there were a number of fine cows. After a time, the rain partially ceased, and we proceeded towards a house, which the herdsmen told us was some little distance further on. The forest was now more open, consisting, to a considerable extent, of some kind of small bamboos, interspersed with gigantic trees; the latter hoary with lichens, or green with climbing plants and pendulous mosses. Birds became more numerous, and the woods were constantly reverberating to the harsh cry of the small cuckoo (*Cuculus poliocephalus*), the pleasing call of the Indian cuckoo (*Cuculus micropterus*), sounding like "koo-koo koo-koo," and the soft sweet notes of our own familiar species (*Cuculus canorus*), bringing home-thoughts in crowds in its train, and carrying us back in memory to days long gone by, when our explorations had not extended to Asiatic forests, or the stupendous hill-sides of the Himalaya! I noticed two or three wood-peckers—I think repre-

sentatives of *Gecinulus grantia*—and a number of tits, and other little birds, which were too distant to identify.

Long ere we reached the house to which we had been directed, the rain came down in torrents, and we were glad enough to take shelter in hollow trees, of which there appeared to be no lack. The white petals of some species of magnolia were plentifully lying on the ground in places, as we went along, and the trees were often gaily festooned with white epiphytical orchids—chiefly of the genus *Cœlogyne*: but few other flowers came under our observation for the remainder of the day.

When the rain had moderated a little in its downpour, we emerged from our hollow trees, and trudged on towards the house already referred to. We soon reached it, but it was crowded with Nepalese, Lepchas, Bhoteas, and even pigs, and was, altogether, such an uninviting-looking place, that we judged it better to push on to a little Ghoorka village, on a hill a short distance ahead. In due course we arrived, and found a few Nepalese huts, perched upon a series of little knolls—each one about large enough for a single house—in the very heart of the forest. Here we resolved to halt for the night, and the verandah of one of the best houses was placed at our disposal, the occupant obligingly furnishing us with extra mats to enclose the impromptu bedchamber. Our people soon arrived, and, with their long, straight knives, they readily cut down some saplings and constructed cots for us. The poor fellows had all got terribly wet; but, cheerful and happy under all circumstances, apparently, they seemed to think nothing of the matter, and I firmly believe that most of them slept in their wet garments all night. We soon had dinner, and then built a huge fire, partly with a view to warm ourselves, for it was getting quite chilly, and partly for amusement. Some of the coolies seemed to think the fire great fun, and, notwithstanding that they had travelled close upon fifteen miles since morning, with loads upon their backs that would astonish an English porter, they were merry as crickets, and ran about everywhere for dry sticks, with which to feed the flame.

We had no instruments to enable us to ascertain the altitude of our position; but, judging by the low temperature, and the almost constant ascent during our march, we guessed that we were not much under 8000 feet above the sea. Bamboos grew round us plentifully amidst the forest: hence the village, for its inhabitants were bamboo mat-makers, who supplied the people at Darjeeling with these necessary articles of comfort. Playing about upon the prostrate logs, which lay around us in all directions, was the exquisitely

beautiful yellow-bellied fantail (*Chelidorhynx hypoxantha*) whistling and spreading out its tail, as it flitted about, with a grace peculiarly its own.

Next morning we were early afoot, and, after the usual chota nazree, S—— and I went on in advance, leaving the servants to pack up and follow with the coolies as soon as they could; we, however, took the wrong path, and had to retrace our steps for about three quarters of a mile, on being overtaken by Tempo, who came speeding after us as fast as his legs would carry him. The road was very slippery and slushy, after the heavy rain; and, instead of a steady ascent, as on the previous day, in consequence of our direction being nearly at right angles with the lie of the ridges, the path was exceedingly undulating, and somewhat fatiguing. After climbing and slipping about for a long distance, we arrived at the foot of a great hill—one of the immediate spurs of Tonglo itself—up which the guides said we should have to go. Here we paused, near a Bhuddist temple, to rest ourselves, and to allow the coolies to come up, for, by this time, they were all a long distance behind us.

Our course, thus far, had led us through magnificent forests of oaks, magnolias, rhododendrons, laurels, and other trees, of the most superb and stately growth, draped and festooned, as usual, with beautiful climbing and epiphytical flowers, brilliantly green mosses, and many kinds of lichens. Birds were scarcer than at the lower elevation of yesterday's travel, but we still occasionally heard the voice of the Indian cuckoo (*Cuculus micropterus*), procured specimens of the hoary bar-wing (*Actinodura Nipalensis*), and met with many Darjeeling black wood-peckers (*Picus majoroides*). The noble yellow-billed blue magpie (*Urocissa flavirostris*) here replaced the red-billed species of the lower altitudes, and the gorgeous Sikkim horned pheasant (*Ceriornis satyra*) was not unfrequently sighted.

The path we had been following led round the sources of the Little Rungeet river, and we now supposed we were close to its infant waters, which, we imagined, lay in the valley on our right hand. Some of the trees in this forest were the finest I had ever seen; in girth, height and luxuriance, they were certainly unequalled in all my previous experience of India, Burmah, the Cape of Good Hope, and North America. One noble oak (*Quercus annulata*) with large and splendid leaves, standing rather apart from its kindred, was a glorious specimen of arborescent vegetation, as it towered above the stupendous forest, and spread its giant arms majestically on all sides.

After nearly an hour's rest, to allow all the coolies to collect, we

braced ourselves for a climb up the steep sides of the big hill already alluded to. The ground was wet and slippery, and the incline so great, that I marvelled how the hill-men, with their naked feet, could maintain their footing as surely as they did; though, now and then, a crash amongst the bushes, and a shout, announced that some unlucky wight had stumbled, and made a closer acquaintance with the greasy soil of the mountain-side than he desired.

We ascended rapidly, and soon left the oak and chestnut forests behind us, entering a dense bamboo jungle, where the stems grew so thickly and so close together, that, excepting along the little narrow foot-track, progress seemed utterly impossible. The bamboos united over our heads at about the height of fifteen or twenty feet from the ground, and, with their dense plumes of foliage, almost shut out the light of day and the warmth of the sun. The whole forest was reeking with moisture, and the foot-path as dark and gloomy as a vault; of which, indeed, it was in the dim and melancholy light of its solemn shade, somewhat suggestive. This bamboo jungle was most singular—the strangest forest I ever saw—and its silent, gloomy monotony so depressing to the spirits, that I felt a positive sense of relief when I emerged from its wilderness of stems, into a comparatively open and sunny glade, where we halted. Here and there, this hill-side was studded with occasional trees, round which some beautiful flowers were growing; and especially welcome and attractive was a lovely white *Convallaria*, resembling, to some extent, that most exquisite of our home favourites, the lily of the valley (*Convallaria majalis*). These trees and their associate flowers, seemed like oases in the great desert of silent, moveless and mournful-looking bamboos.

The glade referred to was a little plain, on a shelf of the mountain, where we found a tolerably large and roomy shed, which we at once appropriated and proceeded to make comfortable, by screening off a portion with the curtains of the tent, and covering our beds with waterproof sheets, as the roof did not appear to be very sound.

After dinner, when it was getting dusk, the air became very chilly, and we were glad enough to light a big fire, which afforded the coolies great amusement, and, I should imagine, no insignificant amount of comfort also.

Bamboo jungle, with enormous forest trees, grew all round us, and so lofty, that we could not obtain any view of the country, or form any correct idea of our exact position, though we supposed its

altitude to be nearly 9000 feet. Immense magnolias (*Magnolia Campbellii*), now out of bloom, and huge rhododendrons, were abundant, and seemed to have almost entirely taken the place of the oaks and chestnuts of the lower levels. Of the rhododendrons, only one species was in flower, the beautiful and fragrant *Rhododendron Dalhousiæ*, which is parasitical in its habits; none of its charming blossoms were accessible to us, but the scented petals strewed the ground in many places. The magnificent *Rhododendron Campbelliæ* was out of bloom, and we missed its gorgeous scarlet bells, where, in the gloom of these glorious but sombre forests, its brilliant hue would have afforded a splendid contrast and been grateful to the eye.

There were numbers of wood-peckers (*Picus majoroides*) in the neighbourhood of our halting place, as well as horned pheasants; and there, for the first time, we heard the delightful call of the white-spotted laughing thrush (*Garrulax ocellatus*). It is a clear, mellow whistle sounding like "awày-awày-awèe," the first two syllables being uttered somewhat rapidly. They readily answered to an imitation of their note, and the forest in our vicinity was fairly ringing with their remarkable and exceedingly sweet voices. Of course we obtained specimens, as we did of nearly all the other birds mentioned as having occurred during the ascent.

As far as I could make out, the shed in which we took up our temporary residence, was a sort of rest-house for travellers, built by the Nepalese, who pursue this route in their journeys to and from Nepal. There is a capital spring of good water near it, but the jungle abounded in leeches, which contrived to insinuate themselves through almost every description of garment, and drew blood copiously.

A good deal of rain fell during the night, and the morning of Thursday the 5th was fine and bright. We started early in the usual order, but my companion shortly afterwards diverged from the path in pursuit of pheasants, and I continued the ascent alone. Bamboo jungle prevailed all over the mountain-side, but it was not so gloomy and forbidding as that previously described, and trees were, perhaps, more plentiful, though I did not observe any very large ones.

In course of time I reached the summit, which is divided by two tolerably deep undulations into three separate tops, of nearly equal height. I was a long way in advance of the remainder of the party, and was fortunate enough to obtain a clear and superb view of the matchless mountains visible from Tonglo; the lower hills and the

plains being, however, shrouded in dense mist. Notwithstanding my recent experience of noble views, I stood rapt and awestruck at the amazing prospect that burst upon me from this point. Language is powerless to convey even a faint idea of the vast and wonderous tiers of stupendous peaks that stretch away north, north-west, and north-east, as far as the eye can reach, forming one dazzling and astounding panorama, which, for grandeur and sublimity, has no counterpart on earth. From Tonglo is visible the highest mountain of the globe,* but, owing to its proximity, the glorious mass of Kunchin jinga is by far the most striking and majestic. In its dread presence, even the colossal peaks of Junno (25,304 feet), Kubra (24,015 feet), Pundim (22,017 feet), and Nursing† (19,146 feet), seemed dwarfed into ordinary mountains, and it stands in its grand and austere magnificence—lonely, silent, and awful-looking—perhaps the most glorious type on earth of the handiwork of Almighty God. This inexpressibly magnificent view is not often revealed at this season, when the atmosphere is heavily charged with vapour; and, within ten minutes of my arrival on the summit of Tonglo, the dense mists that had, all through the forenoon, filled the valleys below us, and covered many of the lesser elevations, rose rapidly on the Nepal side, and partially screened a number of the mountains, while clouds were gathering fast on the Sikkim hills in considerable masses. A quarter of an hour, or so, afterwards, when the rest of the party appeared, the prospect, though still unutterably grand, was greatly marred by the concealment of many of the peaks and the indistinctness of others.

Mount Tonglo is 10,079 feet above the sea level, and it is one of the summits of the huge Singalelah spur of Kunchin jinga, which divides Nepal from Sikkim. It is only about twelve miles distant, in a direct line, from Darjeeling,‡ but, by the road, it must be close upon forty. There are no pines on Tonglo, though their lowest level in Sikkim is about 10,000 feet; but, on a neighbouring hill, which I supposed to be Sakkiazung, we observed a dense crest of silver firs (*Abies Webbiana*). Rhododendrons of great size prevail, and we encamped in the southernmost of the

* Deo-dhunga, or Mount Everest, on the borders of Nepal and Eastern Thibet—29,002 feet above the sea. Dapsing, in Western Thibet (28,278 feet) the second highest peak is not, I believe, visible from Tonglo.

† I have adopted, for the names of these four mountains, the orthography of the Government Trigonometrical Survey Maps, though, apparently, the more modern way of spelling them is as follows,—viz: Jannoo, Kabroo, Pandim, and Narsing. Vide "Journal of the Asiatic Society of Bengal," 1862.

‡ Hooker, "Himalayan Journals," vol. i. p. 155.

hollows before-mentioned, amongst a grove of them. Some were still in flower (*Rhododendron arboreum*), and their brilliant red blossoms looked truly magnificent. Other species were also growing here, with laurels and cherries; a white scentless rose (*Rosa sericea*); a plant resembling in some degree a *Datura*, which I supposed to be *Whitleya stramonifolia*; a blue violet, probably *Viola repens;* and a beautiful *Daphne*, in profuse bloom, which I had no means of identifying. It was, most likely, *Daphne cannabina*, as mentioned by Dr. Hooker.* I also obtained an exquisite patch of a lovely, pale-purple orchid, close to where we were encamped.

Our tents were pitched on the boundary-line, as I understood, between Nepal and Sikkim, close to the site of a small village, now no longer in existence, which was called Mainwaring, after an officer,† who resided there for some time.

In the dip of the mountain close to us, was a little, gloomy-looking tarn, of dark, but clear and good water, and we picked up a number of birds in its vicinity, including *Picus majoroides*, the white-collared ouzel (*Merula albocincta*); the brown finch-thrush (*Heteromorpha unicolor*), the Indian corby (*Corvus culminatus*), the Himalayan nutcracker (*Nucifraga hemispila*), and the black-throated hill partridge (*Arboricola torqueola*). Here also I saw a bird, which I have little doubt was the *Pica Bottanensis*, but I had no gun with me at the time, and my shikaree failed to meet with it.

During the whole of Friday, which we spent upon the summit of Tonglo, we were enveloped in dense cloud, as wet and cold as it was disagreeable. It entirely precluded any view, and rendered all our explorations more or less uncomfortable. A wretched little bird—a lark of some kind—in a copse close to the tent, began the day with a monotonous chirping song, which he continued until it was quite dark, very much to my annoyance; more especially as he displayed a decided objection to being shot, and successfully defied the most unremitting efforts of my shikaree, who made many fruitless expeditions during the day, to the clump of trees in which the pertinacious little rascal resided. No other birds came near us, but I was rather surprised to hear, on the very summit of the mountain, the harsh and well-known voice of *Cuculus poliocephalus*, which seems to affect all elevations from 5,000 to upwards of 10,000 feet.

The next morning was tolerably fine, and, after taking a last look

* "Journal of the Asiatic Society," 1849.

† Major G. B. Mainwaring, of the Bengal staff corps, a distinguished Lepcha scholar, now employed by the Asiatic Society to prepare a grammar and dictionary of that language.

at the great mountains, some of them still partially obscured by clouds, we began our descent in the direction of the Lepcha village of Simombong. The path was exceedingly steep and slippery, owing to the moist and greasy condition of the yellow clay, which abounds along the rocky foot-track. The forest was really glorious, and, in consequence of the comparative absence of the gloomy-looking bamboos, much handsomer than that we had passed through during the upward journey. The red blossoms of *Vaccinium serpens*, which is one of the commonest parasitical plants of British Sikkim, and the white petals of a magnoliaceous flower, strewed the ground in many places; the latter was, probably, the produce of *Talauma Hodgsoni*, as mentioned by Dr. Hooker. * The *Convallaria* already alluded to was very abundant, and the trees were gay with beautiful white orchids of various species. *Cuculus micropterus* and *Cuculus poliocephalus* were constantly heard and seen, as well as the Himalayan magpie (*Dendrocitta sinensis*), the black-browed magpie (*Dendrocitta frontalis*), the maronne oriole (*Oriolus Traillii*), and the Kokla green-pigeon (*Sphenocercus sphenurus*).

On one of the spurs of the hill where stands the Lepcha convent of Simombong, some Nepalese have settled, and here we halted, having obtained possession of a capital shed, in which we made ourselves tolerably comfortable. The forest in this vicinity has almost entirely disappeared, and, in consequence, there is from the little collection of Ghoorka huts, a famous view of Darjeeling and of the broken and picturesque ridges of the Little Rungeet valley. At this place we obtained two kinds of raspberry, one of which, called by Tempo "toom-loom-salem," was red in colour, of large size, and exceedingly pleasant to the taste. Some few vegetable productions are cultivated by the villagers, and we saw a number of flowering plants growing wild; amongst them a purple *Osbeckia* in great abundance.

Next morning, starting early, we descended rapidly to the Little Rungeet river, by a steep and rocky path, partly shaded by trees from the sun, which, according as we neared the bottom of the valley, became oppressively hot. In the vicinity of Simombong the path was bordered by brambles and other English-looking plants, but the vegetation rapidly assumed a tropical character, as we approached the river, and palms, tree-ferns, and huge bamboos, grew all round us in great luxuriance. Amongst the noble trees of the lower slopes were the toon (*Cedrela toona*), the sal (*Shorea robusta*), the sitsal and the sissoo (*Dalbergia latifolia et sisso*), the

* "Himalayan Journals," vol. i. p. 162.

magnificent *Gordonia Wallichi*, and a species of *Terminalia*. A little higher up I saw a pink-flowered *Acacia*, and a grand tree with large leaves and bunches of rose-coloured blossoms; but both leaves and flowers were out of my reach, so that I could not procure specimens. Birds were plentiful, especially doves (*Turtur Suratensis et risoria*), the Himalayan magpie (*Dendrocitta sinensis*), and the striated bulbul (*Alcurus striatus*). I saw also three of the splendid little short-billed minivets (*Pericrocotus brevirostris*), some sun-birds, which I could not identify, a number of the common Bengal bulbuls (*Pycnonotus pygæus*), a species of large pigeon, which I supposed to be *Palumbus pulchricollis*, and the noble and striking-looking rufous-necked hornbill (*Aceros Nipalensis*).

It was exceedingly hot in the valley of the river, and we were glad enough to seek the shelter of some large trees, while we stopped for luncheon. Here our people cut some chungas from the stems of the giant bamboo, which average about five inches in diameter, and they soon got them filled with murwa, an intoxicating beverage made from a kind of millet (*Eleusine corocana*). The grain is put into the chunga, and then hot water poured over it; after it has stood some little time it is fit for use, and is drunk, like a sherry-cobbler, through a tube. The chunga is simply a portion of one of the immense hollow stems of the giant bamboo, about sixteen or twenty inches in length, cut off just below one of the joints, which answers as a bottom to the vessel. The tube is either a reed, or a small hollow branch of bamboo.

The Little Rungeet must be a considerable river in the wet season, judging from its banks; and even at the time of our visit it was tolerably full of clear, but dark water, flowing with a rapid current over a rocky bed, between picturesque banks adorned with luxuriant tropical forest. We crossed it by an excellent cane-bridge, one of those curious works of art, which are characteristic of the Himalayas, and pursued our journey on the opposite bank, along the edge of the river, for some distance; then turning to the right hand we ascended to the shoulder of one of the spurs which overlook the valley. The river bank in many places consisted of reaches of sand strewn with large boulders; and, wherever the former appeared, there were dozens of beautiful butterflies, with their wings outstretched, resting on the cool damp surface. The forest was here eminently tropical in appearance, presenting numbers of dwarf palms, tree-ferns, wild plantains, enormous feathery-looking bamboos, and a few screw-pines. A beautiful *Mussanda*, with white bracts, was plentiful, but I observed no other terrestrial flowering

plants; epiphytical orchids, however, abounded as usual, and in greater variety than on the hills. There were a good many patches of cultivation as we ascended, consisting chiefly of fields of millet and maize, though we actually saw rice in one or two places, and wondered how it grew, apparently without water.

After a short rest on the shoulder of the spur, we descended rapidly once more, to the valley of another river known as the Bulwabos, where there was a Lepcha or Sikkim-Bhotea village. The Bulwabos, like the Little Rungeet, must at times be a large and powerful stream, but the water was so low when we reached it, that a couple of moderately sized branches enabled us to cross dry-shod. We pitched our camp on a patch of green sward, close to the edge of the river, and within a short distance of the village, whither our people immediately proceeded in search of murwa. The banks of the Bulwabos were high, and somewhat precipitous in our vicinity, and a great portion of the bed was uncovered and perfectly dry, consisting of rocks and sand, amongst which a complete little forest of wormwood (*Artemisia Indica*) was growing to the height of eight or nine feet. The dark but clear water foamed and broke over the shallows as it dashed along, though, here and there, pools and eddies were to be seen, reminding one of a trout-stream in Scotland. I saw a large king-fisher (*Ceryle guttata*) close to our camp, as well as a pair of spotted doves (*Turtur Suratensis*), and an owl (*Ketupa flavipes*). As night approached, cicadas, tree-frogs, crickets, and other creatures, commenced a serenade which, mingling with the crash of the river, soon filled the valley with one continuous volume of bewildering sound, and afforded a strange contrast to the silence of the higher altitudes. White ants and beetles, in hundreds, flocked into the tents as soon as our candles were lit, and became so troublesome that we were obliged to put out the light, and go to bed; after which we were left in comparative peace. During the night we constantly saw the glare, and heard the crackling, caused by burning the forest in our vicinity; the bursting of the bamboos sounding like a dropping-fire of pistol-shots. Towards morning, a heavy thunder-shower swept over us, and the rain came partially through the tent, rather to our discomfort, as we had not anticipated anything of the kind.

Near the village of Bulwabos was one enormously tall tree, which the coolies called "dom-shing;" there were leaves upon it, but all out of reach, and so high above us that I could not see them with any distinctness. The tree was said to be sacred.

I met with only one leech in this valley, and Tempo assured us that they are not found so low down. In the upper forests they abounded, and were especially numerous in the long grass and small jungle on the summit of Mount Tonglo. Various kinds of biting flies were our constant companions, and excessively annoying little wretches they were, particularly one, which the Sikkim-Bhoteas called "biong-sem."

On Monday the 10th, we left our camp at Bulwabos for Darjeeling. The day was fine, and, though bright and hot, a friendly mist frequently swept up from the valleys, and protected us during the ascent from the rays of the sun. The climb from the river to the Darjeeling mountain is almost continuous, and somewhat trying from its steepness; before we reached our destination, I was glad to slake my thirst with the yellow raspberry, the insipid little strawberry, and latterly, with the juicy stems of *Polygonum molle*,* which tastes like rhubarb.

The day being, for the most part, clear, we obtained many and varied views of great beauty, increasing in extent and grandeur as we approached the station. Stray patches of cultivation are scattered over the slopes, as also small villages, but they are not picturesque, and their presence has considerably marred the beauty of the forest, which, otherwise, would have extended in a comparatively unbroken incline of about seven thousand feet.

* The species was identified for me by the editor of "Science Gossip."

LIONEL BEALE ON PROTOPLASM AND LIFE.*

The controversy between the "vitalists" and the physicists, if the latter term can be admitted as designating those who deny the existence of a special vital force, does not get nearer a settlement by the progress of discovery or the continuance of research. Both parties may take their share of blame for the mode in which the discussion is carried on, as both resort to positive assertions on matters of which they are profoundly ignorant, and neither seems willing to consider fairly what its opponents have to urge.

That life is as much a mystery now, as when its phenonema first excited the speculations of men, cannot be denied, and, on the other hand, it must be admitted that one operation after another supposed to be the peculiar effect of "vital force," has been traced to physical causes, in which term, using it widely, chemical forces may be comprised. The vitalist who takes Dr. Lionel Beale as his exponent commits the grave error of undervaluing or concealing what has been done in the way of explaining the actions which take place in living bodies, and in showing their analogy to the operations which the student in his laboratory can perform. In fact, there is much in all Dr. Beale's writings and sayings on this subject that is only adapted to those who are quite ignorant of modern chemistry, and easily guided by emphatic affirmations unsustained by proof. Professor Huxley, against whom Dr. Beale, and the whole phalanx of those who would subordinate science to some form of metaphysical or theological speculation perpetually rave, is not without obvious faults. Although not the father of such as are cantankerous in controversy, he is not remarkable for eliminating rancour from his polemics, and he frequently commits himself to assertions more rash than wise. Professor Owen, another distinguished anti-vitalist, appears to have concocted his heretical philosophy somewhat in a fog, as we showed when reviewing his last utterances on the subject, and he comes in as a sort of Ishmael in the fight, with his hand against everybody, and thus provokes everybody's hand to be against him. This learned professor is worse than his great tormentor, Huxley, in thrusting his own personal consciousness into the dispute, and he thinks more of damaging his neighbours than of honestly and patiently ascertaining the truth.

A fundamental objection to the "vital force" philosophers is

* "Protoplasm; or Life Force and Matter." By Lionel S. Beale, M.B., F.R.S., etc. etc. Churchill.

that they do not know, and consequently cannot tell us, what they mean by their pet term. It stands with them as a symbol for anything they cannot explain, and year after year, when they exclaim, "Nothing but vital force could have accomplished this result," the chemist or the physicist replies that in his laboratory the same thing has been done.

To make out the existence and assumed potency of this "vital force," Dr. Beale denies, in the most extravagant way, the existence of anything like apparatus in living organisms. He can find nothing in the slightest degree analogous to the machinery of the chemist, to whom he ascribes means transcending anything which cell-structure can display. The chemist, with a little more knowledge of the matter, confesses that when he endeavours to unravel organic processes or to imitate them, his great difficulty lies in his possessing no means at all comparable to the wonderful varieties of material and tissue which organized beings display.

Dr. Beale propounds an ingenious theory, in which the constituents of a living body are divided into germinal or really living matter; formed, or dead matter; and pabulum, or food. The suggestive value of this hypothesis is overlooked by those whom its author offends by dogmatic assertion, and by something very much like shirking many important parts of the question, and he also labours under the disadvantage of having no direct proof to offer that his views are correct. He applies to the bodies he examines a solution of carmine, and if he finds a disposition in any portion of them to be tinted with that elegant dye, he calls it alive; while, if its affinity for the colouring matter is less, he pronounces it dead. But although his proof is defective, his opinions may be sound, and much might be said in their favour by way of inductive reasoning from known facts.

Dr. Beale is very strong in assertion upon another point. With him matter is either alive or dead; he can recognize no degrees of vitality, but treats it as a something, one, indivisible, and mysterious; to be added or taken away in its entirety, as the case may be. Each philosopher is entitled to define his terms as he thinks best, and if Dr. Beale regards vitality, or the power which underlies all the manifestations of life, as a simple entity, although we may object, we cannot complain. We see no proof that life is a simple quantity, and in our survey of living beings, in all their varieties of action and property, we can find nothing to lead inductively to the hypothesis that all so-called vital phenomena,

from the growth of the yeast-cell to the thought and emotion of the man, spring from one single and simple force.

Dr. Beale, referring to the nutrition of a living cell, affirms that "its active changes are exclusively confined to the germinal matter." "The formed material," he tells us, "is passive, and probably acts like a filter, permitting some things to pass, and interfering with the passage of others." But what right has he to make this assertion? So far as we can understand his writings, he makes it because his theory wants it, and his theory rests chiefly on the tinctorial affinities of carmine. Modern chemistry avails itself largely of the power which certain membranes have of giving a preferential entrance or exit to particular substances. By such means the chemist separates with Graham's dialyser the colloid from the crystalline materials he wishes to dissever; but how poor is his apparatus compared with that of the living body, in which we discover cells of a great variety of glands, each exercising a peculiar power of selection, and capable of eliminating special and peculiar substances from the fluids on which they act. Liver cells, lung cells, kidney cells, and innumerable gland cells, exercise, during the life of the creature to which they belong, and during their own life, special functions, which their membranes cannot perform when death has taken place. Why, then, is not the cell-wall alive as well as the germinal matter, and what is germinal matter but pabulum, brought within a certain circle of chemical change? Van Helmont supposed an Archæus, or presiding spirit of digestion, to animate our stomachs; and surely Dr. Beale's vital force might find occupation in every particle of membrane actively engaged in promoting a special chemical change.

Dr. Beale is occasionally felicitous in exposing the blunders of his opponents, and he shows successfully that the term "protoplasm" has been vaguely and wildly used. He also makes something out of Huxley's *bathybius*, a dreamy creation of our great naturalist, which might perhaps be advantageously pronounced *boshybius*, and left to slumber in the mermaids' caves. Except as a mere matter of chemical decision after they are dead, Professor Huxley is not entitled to declare that the protoplasm of men, oysters, and lobsters is all the same. There must be something which determines dog-protoplasm to grow into dog, and monkey-protoplasm to develop into monkey; but while neither the Huxleyites nor the Bealites have the slightest conception of what it is, both should avoid assertions which attempt to make ignorance look knowing if not wise.

Dr. Beale exclaims, "Now, what can be more absurd than to suggest that the properties of man, dog, butterfly, and amœba are not due to vitality, but to the constituent elements of their tissues? Do the properties of the dog differ sufficiently from those of the elements of man to account for the differences between dog and man? Have we not rather *identity of composition* in the living matter, and marvellous difference in the results of vital actions?"

This passage is a good illustration of the mental haze in which Dr. Beale surveys the subject. No chemist attempts to find the *properties* of a compound in its *elements*. The chemist uses the term element to signify that which has not been decomposed, but no prudent chemist ventures to assert that such bodies are really simple. He deals with them as he finds them. His so-called elements combine with each other in definite ways, and they give rise to a number of compounds which behave like simple bodies, and act as units in fresh compositions, or in certain regulated decompositions. Very often he can remove a definite quantity of what he calls an "element," and replace it with another quantity of what he knows to be a compound. He is also acquainted with a range of bodies which appear to be composed of the same elements in precisely the same proportions, but differing in the mode in which their molecules are arranged, and having properties of a very opposite kind. It appears from his researches that a compound of the same elements, in the same proportions, may be solid, or liquid, or gaseous, poisonous or innocuous, melting or boiling at one temperature or at another, and varying in a host of important particulars simply from the nature of its internal construction—the way in which its molecules are arranged. Dr. Beale is careful in some passages to insist upon the differences between dead matter and live matter, but in the paragraph just cited all prudence departs from him. If the properties of dog elements did not differ *dog*ically from those of man, there would not be the difference we notice between the human and the canine. When Dr. Beale asks "have we not identity of composition," he suggests the propriety of Huxley's polyzoic protoplasm, alike in the oyster and in himself. But what does he mean by *identity of composition?* In one sense, the isomeric bodies of the chemist are identical in composition, and his allotropic conditions of oxygen or phosphorus are the same substance; but a little consideration will show that mode of aggregation has much, if not everything, to do with identity or diversity of composition; and whatever may be the ultimate physical cause of the fact, we know that dog protoplasm in the dog ovum, and

human protoplasm in the human ovum, do widely differentiate at a certain point of development.

In his concluding chapter, Dr. Beale speaks of *will* "as probably the vital force or power of certain kinds of living matter;" and he thinks "instinct and mind" are also "forms of vital power." We do not know how far this will suit the very orthodox establishment to which Dr. Beale is still attached, and of which he was lately the most distinguished professor. It looks like "materialism," which we believe is considered to be a very dreadful thing; but we protest against calling everything, from the forces engaged in digestion to those of mind and will, by one name, and treating them as varieties of "vital force." We can see no connection of *kind* between digesting a mutton-chop, considering the protoplasm controversy, and loving our friends. We do not pretend to understand any one of the manifestations of life, from its simplest to its highest form, but we very positively object to an illogical and unscientific jumbling of all sorts of things together under one vague term.

Dr. Beale says, "in man there seems to be seated, and limited to a special part of his nervous mechanism, a still higher and more wonderful power, influencing a very special and easily destructible living matter. By virtue of this power, man alone, of all created beings, is impelled to seek for the causes of the phenomena he observes, and is enabled to devise new arrangements of material substances for his own definite purposes, and in a manner in which these substances were never arranged before, and in which it is not conceivable they should be arranged without man's design and agency." He further speaks of this power as not correlated with any known modes of force. We do not know what Dr. Beale means by *seating* his power in nerve matter. All physical forces seem to be correlated with each other and with chemical forces, and, so far as we can make them out, they are all modes of motion of what we call matter. We have no evidence that matter exists independent of force, and know of no matter that is inert. What matter is we do not know; what force is we do not know; but we have no reason for accepting old metaphysical notions of matter as a sort of substratum into which properties are stuck. In what way will, thought, or emotion are connected with motions of or changes in nerve matter we cannot tell, or even guess. We are perfectly in the dark on this subject, and we reject the notion of *seating* a power in a structure, just as we discard that of sticking in property into a substratum.

That man alone seeks for causes is scarcely true. If a dog hears a noise, he tries to ascertain what produces it, and all through the higher animals we find similar endeavours to connect certain effects with their causes. Nor is it true that man is the only creature who devises new arrangements of material substances for his definite purposes—the building birds, for example, avail themselves of materials which their ancestors never saw, and, as Wallace has shown, vary their operations as man does, though within a narrower range.

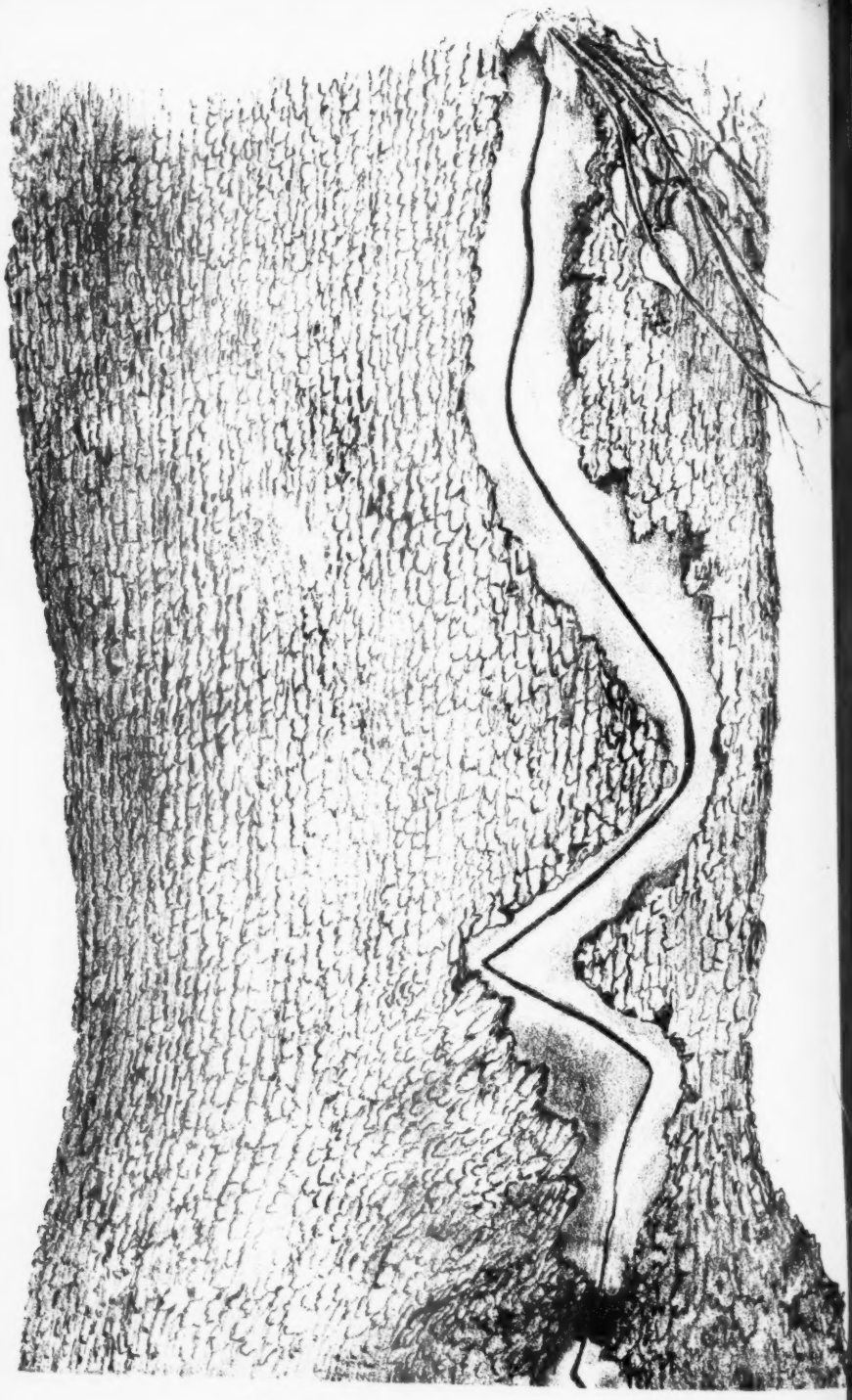
In page 38, Dr. Beale says, "One characteristic of every kind of living matter is spontaneous movement." Would it not be much more correct to say that no living matter moves *spontaneously* in any rational sense of the term. Until we meet in the higher animals, or in man with the highly-complicated phenomena of will and choice, we have no logical right to speak of "spontaneous movements," because all motion, we can explain, arises from the action and reaction of matter in conformity with fixed laws. If anyone asserted that one character of a Hansom cab is "spontaneous movement," he would have as much justification as Dr. Beale has in the words we have cited. Water "spontaneously" dissolves sugar, acids "spontaneously" combines with bases, muscles "spontaneously" contract when electricity stimulates them, liver cells "spontaneously" form bile—what is the use of such phraseology? When living bodies move, there is a physical cause of their motion; if they digest, there are physical causes of digestion. "Spontaneous" indicates accord, or free will, and if Dr. Beale employs it to mean simply the absence of external stimuli, his assertion will not stand. When an amœba moves in a fluid, what right has he to say that it is not submitting to stimuli, just as much as the Hansom cab submits to the pull of the horse? So far as we know, no living cell or particle consists of one kind of matter in one state, and if motion ensues, how does Dr. Beale know it is any more "spontaneous" than the movements which occur when paper is put in the fire?

Dr. Beale is perpetually reiterating, as if it was an ascertained fact, that all living matter comes from pre-existing living matter. This may be so, but it is certainly not *proved;* and if we turn to a writer of an opposite school, we find counter assertions made with as much vehemence.

Pouchet, for example, in his preface to George Pennetier's "L'Origine de la Vie," says, "With any reflecting mind, heterogeny is a logical consequence of the appearance and ascending move-

ment of organized beings on the surface of the globe;" and in another passage he speaks: "Heterogeny is recognized to-day as an irrefragable fact by the most illustrious physiologists of Germany, Italy, England, and America." "Spontaneous" generation in the sense of matter organizing itself of its own accord into life, does not seem a wiser conception than Dr. Beale's "spontaneous" movement of all living particles. "Heterogeny" is a better term; and no one who reads carefully the investigations of the recent observers alluded to by Pouchet can regard the question involved as definitively settled. It has nothing whatever to do with the theological matters with which it is often wrongfully mixed up. Pouchet's philosophy is as theistic and religious as that of Beale, and it is vain to look to the microscope or to physical science for any information concerning the ultimate Cause of all existence. How that Cause acts is traceable by science in a few directions, and to a very limited extent; and if there are conditions under which particles of dead matter, not descended from, or acted upon by living matter, become alive, we shall probably remain exactly as ignorant of how it is accomplished as we are now of how a germinal molecule in an egg begins a course of growth which eventuates in a definite and composite living being.

The study of the physical basis of life, or the physical origin of life, by physical science methods, does not really touch the metaphysical problems which lie beyond it. We do not know that any prolongation of our physical discoveries would bring us one jot nearer the solution of a metaphysical problem. The two lines of inquiry may be parallel, not convergent; and if on each and on all sides freedom is claimed, let no one refuse it to his neighbour, or make a vain pretence of *knowing*, when he only guesses in the dark.



ELM, STRUCK BY LIGHTNING.
AT HANGER HILL, ACTON. 10TH SEPT., 1869

THE LIGHTNING'S AUTOGRAPH.

BY HENRY J. SLACK, F.G.S., SEC. R.M.S.

(With a Plate.)

On the 10th of September last, about 10 o'clock in the morning, a violent thunderstorm was in action in the neighbourhood of London, and a large elm tree, in the grounds of Hanger Hill House, Acton, Middlesex, was struck by the lightning in a very remarkable way. The tree is about forty yards from the house, which stands on a steep hill of considerable elevation, and is a conspicuous object for many miles round. The building is protected by a lightning conductor, and surrounded by fine old trees, many of them of considerable magnitude. The elm on which the lightning acted, is about sixty or seventy feet high and fifteen in girth. It forms one of many similar ornaments of the carriage drive, and, like its neighbours, it was at the time of the storm in full leaf and full of sap.

From Sir Joshua Walmsley, the occupier of the mansion, I learnt that at the time in question a vivid flash of lightning roused the attention of the family, and it was instantly followed by a loud thunder peal. Various rooms in the house were filled with a sulphurous odour, and it was evident that some object in the building or its immediate vicinity had been struck. It was soon found that the great elm mentioned had been grooved, as shown by the dark line in the plate, and the bark stripped off to an average breadth of about nine inches. The groove cut by the lightning was not burnt at the edges or noticeably ragged. It was such as might have been cut with a rather blunt square-edged chisel, driven through the inner bark, and descending a little into the sap wood. It was about three-fourths of an inch wide, and one-fourth to one-half an inch deep, not reckoning the thickness of the displaced outer bark. On the side of the tree represented in the drawing, it took first a slightly meandering course, then sloped to the right, and bent back in a rounded curve to the left, when it made an acute angle, turned again to the right, made an obtuse angle, and went tolerably straight into the ground at the foot of the tree. An examination with a ladder showed that the groove began on the other side, and it was traced to a height of about forty feet and then lost amidst ivy and branches.

The first impression of those who saw it was, that the electric discharge had made an exact imitation of its own zig-zag course through the air; and it may not be inaptly termed the Lightning's Autograph.

The same sort of causes which make zig-zag lightning had obviously acted in the tree. Its discharge had no doubt followed the line of least resistance, and as soon as a sufficient obstacle arose, or a greater facility occurred, bounded off with more or less abruptness, and went straight till a fresh difficulty or a fresh facility produced a new variation.

Those who are familiar with electrical experiments, must have noticed how often a long strong spark from a prime conductor of a frictional machine takes the zig-zag form. As Mr. Gassiot has shown no electric discharge can take place in a perfect vacuum, and if several ways are so to speak open to it, that of least resistance is invariably chosen.

At the time of the 10th of September storm, a heavy rain fell, and this elm was well soaked. Its sap wood was likewise full of vegetable juices, which are better conductors than plain water. Probably a considerable portion of the discharge ran down the wet bark, and only a small portion might have been engaged in cutting singular groove we have figured.

The displacement of the outer bark arose from the action of the discharge upon the moisture in the inner bark and sap wood, part of which must have been instantly converted into steam.

My readers will remember the pretty experiment of the electrical mortar, in which a small ball of ivory, or some such material, is thrown several feet by sending an electric shock from a Leyden jar or battery through the drop of water with which the mimic piece of artillery is loaded. An analogous experiment may be made with a piece of thermometer tube, as a shock sent through a thin thread of mercury contained in its capillary bore, shivers it to pieces by the repulsive force suddenly communicated to the particles of the liquid metal. It is very common, when lightning strikes a tree, to find the bark blown off in all directions, and the soft wood torn to strips; and the writer saw, some years ago, a large oak in Hertfordshire, part of the bole of which had been knocked to shivers by a strong flash, which scattered fragments of wood and bark in a circle many yards in diameter.

That the elm tree at Hanger Hill did not suffer greater injury may be ascribed to the heavy rain falling at the time, and to the good conducting power of its abundant sap. In some places in and near the groove I noticed a slight growth of blue mould, the sap globules, killed by the stroke, having formed a fit medium to promote its development. The tree did not seem any the worse for its accident, but it may possibly suffer next year.

Probably the publication of this statement may lead to similar instances of grooving being pointed out. From Mr. Reeves, the assistant-secretary of the Royal Microscopical Society, I have received the following interesting note, and I shall be glad if any inhabitants of Maidstone who remember the fact to which he alludes will furnish further particulars. Mr. Reeves says—

"I cannot remember enough about the tree being struck with lightning to be of any use to you. It happened about the year 1837, in a gentleman's park near Maidstone, and the curious way the fluid passed down the tree was thought a great deal of; every one in the neighbourhood went to see it. I was an apprentice at the time, and of course did as the rest did. I believe I am correct in saying that the tree was struck near the top, and the lightning passed round and round from top to bottom, leaving a distinct groove. I do not know any one now living in Maidstone, but there must be a great many who remember the circumstance."

ASTRONOMICAL NOTES FOR DECEMBER.

BY W. T. LYNN, B.A., F.R.A.S.,

Of the Royal Observatory, Greenwich.

VENUS will be at her greatest eastern elongation on the morning of the 14th. She will set on the first day at 6 minutes past 7, or 3 hours 14 minutes after the Sun; but on the last day not until 7 minutes past 8. At the beginning of the month she will be in the constellation Sagittarius, but will soon pass into Capricornus, and remain there until very nearly the end of the year, when she will enter Aquarius. As she is approaching inferior conjunction, she will, after the 14th, be slightly horned in appearance.

JUPITER is still very conspicuous in the constellation Aries during the whole of the first half of the night. He will be on the meridian at ten o'clock on the 1st, at nine on the 15th, and at eight in the evening on the 30th. The following table contains the whole of those phenomena of his satellites which will be visible before midnight. The eclipses of the first and second can only be observed at their reappearances, being behind Jupiter at the disappearances. A complete eclipse of the third may be observed on the 3rd, disappearing very near the planet, and reappearing at about a diameter's distance from him on the right hand side, as seen in an inverting telescope. No eclipse of the fourth satellite will take place.

DAY.	SATELLITE.	PHENOMENON.	MEAN TIME. h. m.
Dec. 1.....	I.....	Eclipse, reappearance.....	6 12
„ 3.....	III.....	Occultation, disappearance	6 16
„ 3.....	III.....	Occultation, reappearance	8 7
„ 3.....	III.....	Eclipse, disappearance ...	8 55
„ 3.....	III.....	Eclipse, reappearance.....	10 42
„ 5.....	II.....	Transit, ingress	9 17
„ 5.....	II.....	Transit, egress.....	11 34
„ 6.....	I.....	Occultation, disappearance	10 46
„ 7.....	II.....	Eclipse, reappearance.....	7 48
„ 7.....	I.....	Transit, ingress	8 2
„ 7.....	I.....	Transit, egress.....	10 13
„ 8.....	I.....	Occultation, disappearance	5 12
„ 8.....	I.....	Eclipse, reappearance.....	8 7
„ 10.....	III.....	Occultation, disappearance	9 39
„ 10.....	III.....	Occultation, reappearance	11 34
„ 12.....	II.....	Transit, ingress	11 37
„ 14.....	II.....	Occultation, disappearance	6 22
„ 14.....	I.....	Transit, ingress	9 48
„ 14.....	II.....	Eclipse, reappearance.....	10 24
„ 15.....	I.....	Occultation, disappearance	7 0
„ 15.....	I.....	Eclipse, reappearance.....	10 3
„ 16.....	I.....	Transit, egress.....	6 27
„ 21.....	III.....	Transit, egress.....	5 0
„ 21.....	II.....	Occultation, disappearance	8 43
„ 21.....	I.....	Transit, ingress	11 36
„ 22.....	I.....	Occultation, disappearance	8 48
„ 22.....	I.....	Eclipse, reappearance.....	11 59
„ 23.....	II.....	Transit, egress.....	5 31
„ 23.....	I.....	Transit, ingress	6 3
„ 23.....	I.....	Transit, egress.....	8 15
„ 24.....	I.....	Eclipse, reappearance.....	6 28
„ 28.....	III.....	Transit, ingress	6 32
„ 28.....	III.....	Transit, egress	8 37
„ 28.....	II.....	Occultation, disappearance	11 6
„ 29.....	I.....	Occultation, disappearance	10 37
„ 30.....	II.....	Transit, ingress	5 38
„ 30.....	I.....	Transit, ingress	7 52
„ 30.....	II.....	Transit, egress	7 58
„ 30.....	I.....	Transit, egress	10 4
„ 31.....	I.....	Occultation, disappearance	5 5
„ 31.....	I.....	Eclipse, reappearance.....	8 24

THE MOON is New at 10h. 41m. on the morning of the 3rd; in First Quarter at 11h. 12m. on the night of the 10th; and Full at ten minutes before midnight on the 18th. We give the following table of the circumstances of four occultations of stars by the Moon, which will be visible during the first half of the night. The angle V denotes, as usual, the angular distance from the Moon's highest point at which the disappearance or reappearance takes place, measured towards the right hand round the circumference, as seen in an inverting telescope.

DAY.	STAR.	MAG.	DISAPPEARANCE.		REAPPEARANCE.	
			MEAN TIME.	V.	MEAN TIME.	V.
			h. m.	°	h. m.	°
Dec. 8	δ Capricorni ...	3	5 36	164	6 35	270
„ 14	ξ^2 Ceti	4	9 21	75	10 15	2
„ 18	χ^1 Orionis	4	10 27	94	11 42	258
„ 21	δ Cancri	4	9 39	12	10 32	257

THE AMERICAN ECLIPSE.—Dr. Gould gives, in a recent number of the "Astronomische Nachrichten,"* an account of the observations made of the total eclipse of last August by the party to which he was attached, which was organized by Professor Coffin, and went into the State of Iowa. The spectroscopic observations were made by Professor Young, who found three lines in the spectrum of the corona, corresponding to about 1250, 1350, and 1474 of Kirchhoff's scale. The two former were faint, but the latter was conspicuous, and its place was carefully measured. It is curious that this last is given as an iron line both by Kirchhoff and Angström. "Can it be," asks Dr. Gould, "that any unknown element is habitually occluded with iron, as hydrogen may be with palladium?" This line, he remarks, is certainly identical with one observed in the spectrum of the Aurora Borealis, and it is probable that the other two are so also.

Dr. Gould's gave his own attention principally to searching for any possible new planet near the Sun, and to a general study of the corona. The former object was also pursued by Professor Newcomb, but the results were wholly negative. Dr. Gould succeeded in seeing π Leonis, a star of the 5·8 magnitude, though scarcely 50′ from the Sun's limb; but there was certainly no other star as bright

* No. 1776.

as the 5th magnitude within 25′ of the ecliptic for 2° on either side of the Sun, or as bright as the 6th magnitude at an equal distance beyond those two degrees.

With regard to the corona, Dr. Gould's personal impression tended to its being rather an atmospheric than a cosmical phenomenon. Its form varied continually, and he obtained drawings for three epochs at intervals of one minute. "It was," he says, "very irregular in form, and in no apparent relation with the protuberances on the Sun, or the position of the Moon."

New Planet.—No. 109 of the group of minor planets was discovered by Professor C. H. F. Peters at Clinton, New York, on the 9th of October. This is the second of those discovered this year, the former being Hecuba, which was found by Luther on the 2nd of April. We mentioned in the March number of The Student that twelve of these bodies were detected in the course of last year; but as many of these were then unnamed, we will take this opportunity of giving the names of all the 1868 discoveries. They are, Ægle, Clotho, Ianthe, Dike, Hecate, Helena, Miriam, Hera, Clymene, Artemis, Dione, and Camilla. Six of these were discovered by Professor Watson, of Ann Arbor, Michigan, U.S., one by Peters, and one by Pogson at Madras. Four only of the twelve, therefore, were first seen in Europe.

Tempel's New Comet.—The comet discovered by Herr Tempel at Marseilles on the 11th of October (not the 9th, as reported by mistake in our "Notes" in the last number of The Student), was observed on the morning of the 13th by Dr. Tiele at Bonn.* Professor Weiss also observed it at Vienna on the mornings of the 13th and 14th, and remarked that it resembled a tolerably bright, round nebula, strongly condensed in the middle, in which a small star-like nucleus became perceptible in the advancing twilight. Herr Vogel obtained an observation on the morning of the 24th of the same month, notwithstanding the brightness of the Moon, which was then only between three and four days past the Full. Indeed he states that the comet was bright enough to be easily observable, even under those circumstances. It was round, 1·2′ in diameter, and had the appearance of a planetary nebula, with a star-like nucleus, equal to a star of the 11th magnitude, in the centre.

Dr. Winnecke, who, during his residence at Karlsruhe, has been by no means unmindful of the heavenly bodies, observed this comet there on the mornings of October 18th and 23rd, and Professor Weiss obtained some additional places at Vienna on those of

* "Astronomische Nachrichten," No. 1778.

October 28 and November 1. The comet has been running so rapidly towards the south, that we are not likely to hear of any more observations in the northern hemisphere; but as it was nearest the Earth about the end of last month, the southern astronomers must have had better opportunities with it than ourselves.

From the elements calculated by Dr. Oppolzer, it appears that this comet moves in a parabolic orbit, which is inclined at an angle of 68° 33′ to the ecliptic; that it passed its perihelion on the 9th of October, about noon, at a distance from the Sun of 1·23 times the Earth's mean distance, or about 112 millions of miles; that its motion was retrograde; and that it was nearest the Earth on the 28th of November, when it approached us within about 115 millions of miles. It will be known as Comet II., 1869, as the periodical comet of Winnecke counts as I., 1869. Of the latter we have now again a few words to say.

Winnecke's Periodical Comet.—In taking leave of this small body, of which we are not likely to hear any more, until its next return in the spring of 1875, we have a few additional observations of it to report. Professor Argelander, whose name has made the Bonn Observatory so famous, obtained several in September, the last of which was made on the night of the 15th of that month.* They were not, however, considered by him as very satisfactory, on account of the feeble and diffused light of the comet. Mr. J. I. Plummer also succeeded in observing it at the Durham Observatory on the night of the 13th of September. But the last observation of it appears to have been made by Herr Vogel, at Leipzig, who obtained one so late as on the 11th of October,† a little before midnight. He found it, however, excessively faint, and believed that it would not be possible to see it again.

The November Meteors.—The weather in the neighbourhood of London, and so far as we have yet learned, over England generally, was very unfavourable for the observation of the meteors last month. On the morning of the 13th, a few were seen at intervals between the clouds; but the following night afforded no opportunity for further search. We have heard that a considerable number was seen at Glasgow and Madrid, though not equalling that of last year. But, at the time of our writing, full reports have not been received.

We have not seen attention anywhere called to the fact that the

* "Astronomische Nachrichten," No. 1778.

† "Astronomische Nachrichten," No. 1780.

periodic time of these meteors is almost exactly three times that of the periodic change of the number and frequency of the solar spots, the former being one-third, and the latter one-ninth of a century. Of course we do not say that there is any physical significance in this; but such coincidences are always deserving of notice.

THE DECEMBER METEORS.—We called attention in the eleventh volume of "The Intellectual Observer" (p. 391), and in the second volume of THE STUDENT (p. 201), to the interesting remarks of Professor D'Arrest and Dr. Weiss, with regard to showers of shooting stars which have sometimes been observed about the 6th of December. It appears that about that time the Earth passes through the orbit of the remarkable comet known as Biela's, which it would seem has suffered complete dispersion, and of which we gave a history in vol. xi. (p. 208, *et seq.*) of "The Intellectual Observer." It also appears probable that another comet, perhaps once a part of Biela's, but now at a great distance from it, moves along the line of its orbit. The December meteors were seen in unusual abundance in the years 1798 and 1838, the interval between which amounts to just six periods of Biela's comet, and this may have been due to the recent passage through the positions of the Earth at those times of another comet—possibly one which was observed once only, and that very imperfectly, in 1818. We cannot expect them to pass this month through a thick part of this supposed meteoric ring; nevertheless it will possess some interest to notice whether any considerable number is seen about the 6th or 7th, about which time we shall again be in the orbit of the comet or comets.

VARIABLE STARS.—We have the following list of four periodically variable stars, which may be expected to attain a maximum of brightness during the present month. There are also four others, R Scorpii, R Corvi, R Ophiuchi, and R Herculis, which also come to an epoch of greatest brightness about this time, but which are not in a part of the sky adapted to observation in this part of this world.

NAME OF STAR.	R.A.	N.P.D.	PERIOD.	MAGNITUDE WHEN		DAY OF MAX.
	h. m. s.	° ′	days.	Max.	Min.	
T Ursæ Majoris	12 30 26	29 47	256	6·5	13	Dec. 9
S Cygni.....	20 2 46	32 23	323·3	8·8	13	„ 13
R Aquilæ	19 0 4	81 59	349·5	6·7	11	„ 30
R Cygni	19 33 18	40 6	425·0	6·2	13	„ 5

THE STUDY OF THE PLANETS.—STEREOGRAMS OF MARS.*

The study of the larger planets offers a pursuit of great interest, we might say, of fascination, and it is entering a stage in which important discoveries may be anticipated as the reward of patient observers with instruments of respectable power. Little can be done with small telescopes of three or four inches diameter, except on very favourable occasions; but thanks to Mr. Browning and Mr. With, exquisite instruments, with silvered mirrors of six and a half and eight and a half, and larger apertures, may now be obtained for the price that used to be paid for small achromatics; and thus a considerable number of persons, hitherto precluded by the expense of the process, may now enter upon the examination of such bodies as Mars, Jupiter, or Saturn, with good prospects of success. As for Venus, unless some change in her mode of behaviour leads to the revelation of more of her structure than can be ordinarily seen through her dazzling robe, she must remain a mystery of shining cloud and dubious spots.

In Mars we have a planet bearing sufficient analogy to our Earth to be much more intelligible than either Jupiter or Saturn. The existence of oceans, and solid continents, polar snows, etc., in Mars, seems well established; but the atmosphere of this planet is as capricious, or more so, than our own, and only by combining with artistic skill, and according to the proper rules of perspective, objects seen at a great variety of times, is it possible to construct a globe or chart of this remarkable body.

Some time since, Mr. Browning constructed a globe of Mars, which, though not the earliest attempt of the kind, was the "first really satisfactory attempt," as Mr. Proctor observes, "to represent the Martial feature in this manner." From this globe, by a very skilful process, Mr. Browning has prepared stereoscopic slides, which realize in a very remarkable manner the probable aspect of the planet if we were near enough and big enough to look at it with our two eyes.

The important discoveries of the late Mr. Dawes, and Mr. Browning's own observation, are embodied in these stereograms, which no student of astronomy should be without, and which will be recognized

* "Four Stereograms of Mars, Photographed for the Stereoscope," by John Browning; "Remarks on Browning's Stereograms of Mars," by Richard A. Proctor, B.A., F.R.A.S., Author of "Saturn and its System," etc., etc. John Browning.

as elegant additions to any collection of stereoscopic slides. From the atmospheric difficulties which Mars puts in the way of his observers, it is highly important that they should know accurately what has already been seen. This will often help them to make out markings that are indistinct; and on the happy occasions when the planet's features are plain, Mr. Browning's stereograms will be of great value in distinguishing fresh details, or noting any changes that may occur.

If we contemplate these exquisite stereograms from a geological point of view, we are disposed to come to the conclusion that Mars is not in the same stage of progress as our Earth. Being a smaller body than our own globe, its diameter being 4100 miles, and its volume about one-seventh of that of the Earth, we may conclude that it may have cooled from the incandescent stage quicker than our planet; but its mean distance from the sun is 145,000,000 of miles, and thus it would receive less than half ($\frac{43}{100}$ths) of the light and heat which the great central orb of the system sends to us. Now lessening the quantity of solar force transmitted to a planet in a given number of ages, would retard those geological changes which depend upon raising immense quantities of vapour by solar heat, and their precipitation in torrential or milder rains. Views of Mars such as Mr. Browning has made so accessible, coincide with this consideration, and we notice a predominance of massive continents with few minor indentations, the marks in which, probably representing water, do not at all correspond with terrestrial river systems.

If we should find ourselves justified in assuming that Mars is in that stage which is here supposed, it is obvious that many important comparisons might be instituted between the present condition of that planet, and the condition in which our Earth appears to have been before extensive actions of aqueous and atmospheric denudations had modified its surface. The patches of (supposed) polar snow on Mars are very curious, and possibly certain bright markings may be interpreted as belonging to snow-fields, or even to a glacial system.

We throw out these merely as hints for our telescopic friends to work upon, and strongly advise their frequently contemplating Mr. Browning's stereograms as highly suggestive of theories they may wish to test.

Mr. Proctor, availing himself of previously existing materials, and of new observations made according to his request by Mr. Browning, finds the rotation-period of Mars to be 24h. 37m.

22·735s., differing only a little from Kaiser's result, which was 24h. 35m. 22·6s. Mr. Proctor considers his calculation to be within ·005s. of the true value.

If we regard Mars as in a stage approximately similar to that of our Earth, what are we to say of Saturn and of Jupiter? Do both these huge bodies represent much earlier, that is, less cooled and less modified states of planetary being? The subject is far too long to enter upon cursorily, and will, we hope, be treated of by Mr. Proctor in a forthcoming work. All that we would now do is to call special attention to Jupiter, as the great "cloud-compeller" is and has lately been at strange performances with the huge masses of vapour that so brilliantly *obscure* the greater part of his globe.

Early in the month Mr. Slack noticed that Jupiter's belts were quite different in tint and form from last year. With a fine With-Browning six and a half inch reflector, he saw them of a pale chocolate colour. Later, Mr. Browning made the planet the subject of one of his exquisite coloured drawings, which he has shown at a meeting of the Astronomical Society, and it appeared that with his large reflector (twelve and a half inches) bright yellow and other hues appeared. In the middle of last month (November) Mr. Slack saw the equatorial belts in momentary glimpses of fine definition, exhibiting brilliant chrome yellow tints, with very bright white cumulus cloud-marks; and on comparing notes with Mr. Browning, he found that gentleman had seen the same thing. The whole aspect of the planet now suggest violent and peculiar action. Let all watch who can.

POUCHET'S "UNIVERSE."*

THE translation of Pouchet's popular work, entitled "The Universe, or the Infinitely Great and the Infinitely Little," just issued by Messrs. Blackie and Son, demands more than a passing notice, as it is the most splendid book of its kind we have met with for a long time—indeed, we might go further, and pronounce it the finest of its class ever brought out. We suppose that when the French publishers determined on the production of such a costly volume, they reckoned upon an amount of support from public libraries and state institutions which cannot be obtained in this country. Year after year it remains a national disgrace that we have so few public libraries, and students in the majority of large towns, and in nearly all small ones, have no chance of seeing a scientific work, or one of historical research, unless they can make a journey to some more fortunate locality, or afford the cost of purchasing it for themselves. Beautifully illustrated volumes, magnificently printed, can rarely teach more science to a hard-working student than he can learn from a cheap and humble edition; but there can be no question as to their influence in stimulating a taste for the cultivation of the branches of knowledge on which they treat. It is on this account that we place a high degree of value upon them, as all must do who are anxious for the spread of substantial knowledge, and who have had any practical experience of the difficulty of insinuating it into ordinary society. Science has still a hard battle to fight in this country. The mercantile man thinks it interferes with business unless it is devoted to some technical process by which he knows money can be made; the rich idlers find it too troublesome; and, as a body, the clergy hate it because they are profoundly ignorant of its lessons, and have a vague fear that it is not good for their craft. Members of successive governments know as little about it as possible, and perhaps the Duke of Argyll is the only cabinet minister we have had for many years whose acquaintance with any one branch surpasses what might be obtained easily by any boy in a decent school.

Whoever, under these circumstances, will smooth the path to a knowledge of things as contradistinguished from idle talk about words, deserves our hearty thanks; and such works, as the

* "The Universe, or the Infinitely Great and the Infinitely Little." By F. A. Pouchet, M.D., etc. Translated from the French. Illustrated by 343 engravings on wood, and four coloured plates from drawings by A. Faguet, Mesnel, Emile Bayard, and J. Stewart. Blackie and Son.

translation Messrs. Blackie have produced, strew the road with honey and sugar at every step.

M. Pouchet has introduced some of his own crotchets into his treatise, and he has maintained in reference to infusoria, the polygastric theory, which is generally abandoned, and also credited them with a blood circulatory apparatus they do not probably possess. These and other blemishes are trifling when compared with the merits of his work, which consist in its varied adaptability to popular tastes. No ordinary person, man, woman, or child, can look at his pictures without being tempted to read a description of what they depict, and the type-pages have an enticing pleasantness which a bibliophil must praise.

The "Invisible World," not of ghosts, but of animalcules; the "Architects of the Sea," "Insects," "Rangers of Forests," "Protectors of Agriculture," "The Architecture of Birds," "The Migrations of Animals," supply topics for the first portion of the volume; while the second treats of "The Vegetable Kingdom," including the "Anatomy of Plants," "The Physiology of Plants," "The Seed and Germination," "Extremes in the Vegetable Kingdom," and "Migrations of Plants." A third part is headed, "Geology," and includes "The Formation of the Globe, Fossils, the Mountains, Cataclysms, Upheavals of the Globe, and Volcanoes and Earthquakes, Glaciers, Caverns, Steppes," etc.; and "The Air and its Corpuscles," in which last chapter M. Pouchet makes his customary assault upon the "panspermists," and sustains his own well-known views. The fourth portion of the volume relates to the "Siderial Universe," and the fifth, to "Popular Errors concerning Monsters," etc. Here certainly are a number of dainty dishes, and we must confess that the author has served them up in a most attractive style. The majority of the plates and wood-cuts are extremely good; many reaching a point of artistic merit and beauty very uncommon in the production of our own countrymen. The best of the numerous landscape illustrations, especially, are characterized by a gradation of tint, and an aerial perspective which we rarely find equalled. The astronomical illustrations are not equal to the rest—some to tell the plain truth, are abominably bad, such as the full moon, lunar mountains, etc., and those of the nebulæ are little better. The coloured plates, on the other hand, possess great merit, and it is really a treat to look over so beautiful a book.

THE MOHAMMEDAN HISTORY OF EGYPT.

BY E. H. PALMER, B.A.,

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CHAPTER IV.

THE BAHARITE DYNASTY.

Mo'ezz eddín Aibek el Turkomaní began the Baharite dynasty, the great Memlouk family, who exercised so powerful an influence upon the destinies of Egypt. Having cast his predecessor, El Melek El Ashraf Músá, into prison, and left him to perish there by a miserable death, he remained for some time in undisturbed possession of the throne. But his own tenure of office was fated to be but of short duration, and he himself soon added one more to the number of Egyptian sultans whom court intrigues and the jealousies of Harem life had hurried to their doom. His beautiful wife, Shegeret ed Durr, suspecting him of infidelity to his vows, caused him to be treacherously assassinated, A.D. 1256. He was succeeded by—

2. El Mansúr Núr eddín Áli, A.D. 1256—1259.

His extreme youth rendered him incapable of governing a kingdom so distracted by seditious factions, and it was not long before the regent,

3. El Mozuffer Sayf eddín Kutr el Moezzí, A.D. 1259—1260,

His father's viceroy, threw him into prison, and himself assumed the reins of government. The unfortunate Mausúr [Sharef eddín also, who had taken a considerable share in the affairs of state during the reign of the last of the Aiúbí princes, El Ashraf, was at once put to death by the new sovereign. His attention was, however, shortly diverted from domestic intrigues to matters more closely affecting the general safety. The Tartar chief, Halákú Khan, grandson of the great conqueror Genghíz Khan, whose invasion and destruction of Bagdad has been before detailed, despatched a messenger to El Mozuffer with a most peremptory missive demanding his immediate and unconditional surrender. El Mozuffer treated the insulting demand with silent contempt, and at once prepared for hostilities. An army was despatched under the command of El Melik Ez Záhir Beybars, who completely routed the barbarian hordes, and recovered possession of the whole of Syria. It had been agreed between the sultan and his general,

that should the latter prove victorious over the Tartar invaders, he should receive the province of Aleppo as his reward. El Mozuffer with characteristic want of faith neglected to fulfil his promise, and was in consequence shortly afterwards assassinated by the offended chief.

4. El Melik Ez Záhir Beybars el Bendúkdárí, A.D. 1260—1277, Himself seized the vacant throne. He had been originally a slave of the seventh Aiyúbí sultan, El Melik es Sáleh Nejur eddín.

At the commencement of his reign, Syria was again invaded by the Tartars; but Beybars, by the quickness of his movements and excellence of his tactics, soon succeeded in completely overcoming his foes, and driving them out of the country. Not content, however, with his previous triumphs, in 1264—5, he again marched into Syria, and took Cæsarea and Ursoof, from which period his whole energies seem to have been more or less concentrated upon operations against the Christians. Armenia fell before his victorious arms, and even the remoter district of Anatolia was threatened with Mussulman domination. During a subsequent war, Antioch also was taken; but the terrible atrocities which were perpetrated during this campaign sullied the otherwise fair fame of this soldier-prince. About this time, his old enemies, the Tartars, again made various inroads into Syria; but little or no success attended their attempts. In the battle of Beyreh they were completely routed, and forced to flee for refuge to the mountain fastnesses of Kurdistan.

Beybars died in the year A.D. 1277, at Damascus, whither he had retreated after a successful crusade in Anatolia. His great physical energy and military prowess render him one of the most illustrious of the rulers of Egypt. The extreme barbarities, however, which attended his conquests are a sad blot upon his escutcheon. It was in his reign that the Caliphate was removed from Damascus to Egypt, where it became a mere nominal authority, or, at most, exercised in matters of religious discipline. To Beybars is due the erection of the grand mosque El Ezhar, in Cairo. His works in Egypt were both extensive in their character and beneficial to the country. Damietta was rebuilt farther inland; the devastation too often caused by the sudden overflow of the Nile was in a great measure obviated by the construction of a large breakwater; and the ramparts at Alexandria, as well as the celebrated Pharos, were effectually repaired.

The next sovereign was—

5. Mohammed é Sáíd hárir eddín Barakat Illah, A.D. 1277—1278.

He reigned but a very short time, for a rebellion of his mi-

nisters forced him to seek refuge from a violent death in abdication. He went into retirement at Kerek, where he died.

6. El Aádel Beder eddín Salánush, his brother, succeeded him, A.D. 1278—1279. He was called "the son of the Bedawí woman," and, as he was but a mere youth at the time of his accession, Kaláún el Alfi acted as regent. He reigned only five months, at the end of which time Kaláún conspired against him, and procured his deposition.

With this prince terminated the Baharite Memlouk dynasty, after occupying the throne of Egypt for twenty-nine years. The reign of this dynasty, though distinguished by many brilliant military successes, was marked by the most dreadful atrocities, and presents a sickening monotony of conspiracies, perjuries, and assassinations.

A division of the Baharite dynasty, Dowlet el Kalúméeh e'Salahéeh, succeeded.

1. El Mansóor Kalaóon, A.D. 1279—1290,

Who had contracted an alliance with a daughter of Beybars, and was, in consequence, a near connection of the previous sultan. Soon after his accession, he dispatched an army into Syria, and, after a short but decisive battle, he recovered Damascus, lost to Egypt since the death of Beybars. In the year 1281, he defeated a very superior force of Tartars, and raised the siege of Rahabeh, he himself assuming the command of his forces; but, like the previous sultans, his conquests appear only to have incited him to enact terrible deeds of bloodshed and rapine. Later in his reign, he besieged and took Tripoli, which, for two centuries, had been in the possession of the Christians, and was a large and flourishing city. No less than seven thousand defenceless inhabitants were put to death in the sacking of the town; and even afterwards, a large number fell victims to needless and wanton butchery. In Cairo, the large and beautiful hospital of Morostán still perpetuates his memory. He founded it in the year 1286, as a reparation, it is supposed, for the great tyranny which he practised in enforcing an obnoxious edict. He died in the year A.D. 1290, and was succeeded by his son—

2. El A'shraf Saláh eddín Khalíl, A.D. 1290—1293.

This prince rendered himself famous by the siege and capture of Acre from the Christians in the first year of his reign. This was the final blow to the hopes of the Crusaders in Syria. Thousands of them were massacred in cold blood, and the most horrible barbarities were practised. A'shraf, however, did not live long to enjoy

the fruits of his conquest, for, two years afterwards, he was assassinated in Egypt. His son—

3. El Melík El Caher Beyder, A.D. 1293,

Succeeded him. He only reigned one day, for, in an angry quarrel, he was killed by his brother,

4. E'háser Mohammed Ebn Kalaóon, A D. 1293—1294.

He reigned for one year; at the end of which his regent (for he was only nine years old), Ketbogha, following the example of El Munsóor Kalaóon, usurped the throne.

5. El Aádel Ketbogha el Mansoóri, A.D. 1294—1296.

The reign of this prince seems to have been by no means a prosperous one. Soon after his accession a pestilence and famine caused great distress and loss of life, and the Tartars seeing the pitiable condition of the Syrians, once again ravaged the country. Ketbogha despatched an army under the command of his chief general Lagín, but the valour of his troops was unable to withstand the overwhelming numbers of the foe. The sultan's forces were driven back with great loss, and Ketbogha was deposed on the ground that he had not commanded in person. His minister—

6. El Mansúr eddín Lagín, 1296—1299,

Succeeded him. Of an amiable and retiring disposition, this prince was hardly fitted to govern a country so distracted by treasons and feuds, and hence in a little more than two years he fell a victim to a conspiracy. A short period of confusion then ensued, during which an emír was made king.

7. E' Náser Mohammed (restored), A.D. 1299—1309,

Was, however, now recalled from his exile at Karak, whither he had been sent by Ketbogha, and again elected sultan. The first act of his second reign was to lead an army against the Tartars, by whom he was completely defeated in the plains of Hims. E' Náser was not daunted, however, for in a second expedition he gained a very decisive victory over them near Damascus, after three days' severe fighting. On his triumphal entry into Cairo after the battle, he was preceded by nearly two thousand prisoners, each carrying the head of a comrade slain in the engagement. E' Náser reigned in peace till 1309, when despairing of ever throwing off the ascendancy of two of his most powerful emírs, Beybars and Silár, who had gradually obtained a complete control over him, he voluntarily abdicated in favour of the former, and retired again to Karak. During the second reign of this prince a great earthquake took place at Cairo, demolishing half the city; Alexandria, too, with other towns of Egypt, suffered considerably from it.

8. El Medeffúr Rúku—eddín Beybars, A.D. 1309—1310,
Then usurped the throne. He was not, however, destined to hold a long tenure of office, for E'Náser, regaining his courage, placed himself at the head of an army, marched to Damascus, and was there proclaimed king. Thence he went to Cairo, where he was acknowledged without opposition. El Medeffúr fled at his approach, and having rendered himself obnoxious to the populace during his brief reign, was assailed by a large crowd on his exit from the city, and by them was stoned to death.

9. E' Naser Mohammed, A.D. 1310—1341,
Now for the third time ascended the throne of Egypt, and enjoyed a long, and, for the most part, tranquil reign. Many improvements were effected throughout his dominions; agriculture and the arts flourished, and Cairo was much beautified by the erection of various handsome buildings. But another persecution of the Christians occurred in 1322; who revenged themselves by setting fire to a large number of mosques and houses in the metropolis. Much disorder was occasioned, and a vast number of Christians were put to death. The sons of E' Naser followed him in succession, but as their reigns were short and troublous, there is no need of any particular mention of them, further than their names.

10. El Munsúr Abú Bekr, A.D. 1341.

11. El Ashraf Kégek, A.D. 1341—1342.

12. E' Náser Shaháb eddín, Ahmed, A.D. 1342.

13. E' Sáleh Ismáil, A.D. 1342—1345.

14. El Kámel Shabán, A.D. 1345.

15. El Medeffúr Hájí, A.D. 1345—1348.

These sultans were only raised to the throne to be exiled or assassinated. Hájí's successor was—

16. E' Náser Hassan, A.D. 1348—1351,
Who was deposed by his brother.

17. E' Sáleh, Saláh—eddín, A.D. 1351—1354.

Hassan, however, soon regained his authority, in *his* turn deposed E' Sáleh, reigned seven years, and was at length put to death by his Memlouks. He built the beautiful mosque in Cairo which bears his name.

18. E' Náser Hassan (restored), A.D. 1354—1361.

19. El Mansúr Mohammed, A.D. 1361—1363,
Son of El Medeffúr Hájí. He reigned six months, and was then deposed by—

20. El Ashraf Shabán, A.D. 1363—1377,
Son of Hassan. This sultan was the first who ordered the sherífs,

or descendants of Mahomet to wear green turbans. During his reign the king of Cyprus besieged Alexandria, but was repulsed with great loss. El Ashraf was at length strangled by his emírs, who were incited by the intriguing Khalífehs, who, although merely guests at the court, used their religious influence against their patrons. His successor was his son.

21. El Mansúr Ali, A.D. 1377—1381.

In his time the famous Berkúk, the founder of the Circassian dynasty rose to the regency.

22. E' Sáleh Hají, A.D. 1381—1382.

This king was dethroned by Berkúk. He was restored however, but again deposed by the regent, and this time with the loss of his life. With this sultan terminated the division of the Baharite dynasty after a reign of one hundred and three years.

The Circassian or Burgite Memlouk kings, succeeded. They were originally slaves, as the former sultans had been, purchased by the Aiyubite princes at various times, with the view of strengthening their authority, and for that purpose were placed in garrison towns, which they guarded with the utmost fidelity. The name "Burgite," signifying "of a tower or castle," indicates their former employment. It may be remarked, that while many of the sultans of both this and the last dynasty retained possession of the throne but for a brief and troublous period, many of the latter met with a violent death, but few of the former. This may be attributable to the fact that the sultans of the Circassian dynasty kept a more careful supervision of state affairs than did their Baharite brethren, and in consequence fewer conspiracies against the life of the reigning prince were likely to arise.

The first monarch of this dynasty was—

E' Záher Seyf—eddín Aboo Berkook, A.D. 1382—1399.

His reign is remarkable for his war with the Tartars, under the celebrated Timúr-lang, commonly known by us as Tamerlane, who first appeared as a formidable foe in the time of the Baharite king E' Náser Hassan. In the year 1393, Berkook having fully equipped a large army, marched into Syria, and twice repulsed Timúr-lang with great loss. Some time after this, the conquest of India diverted the attention of the latter from the injury he had received at the hands of Berkook, and although he does not appear to have contemplated any further attack, yet the sultan did not allow his vigilance to relax, but, by every means in his power sought to insure the safety of his kingdom.

Berkook died suddenly, after a day's illness, in the year A.D.

1399. He was one of the most popular monarchs that ever controlled the destinies of Egypt. Much beloved by his subjects, he was looked upon as their strongest safeguard against their Tartar foes. He was called "Sheykh," for the solidity of his views and his quick-sighted intelligence, and with these qualifications were combined those of an able general and an excellent king. He was discreet, energetic, and provident—possessing all the military talents of Beybars without his severity. He was succeded by his son,

2. E'háser Fúrreg, A.D. 1399—1406,

Who, lacking the good qualifications of his father, fell a prey to intestine troubles, and the inroads of the invader. In the early part of his reign, the governor of Syria having revolted, Fúrreg placed himself at the head of a large army, took him prisoner, and put him to death. Directly after this victory, his father's old enemy, Timúr-lang, again threatened the country. A battle was fought, Fúrreg was defeated, and Aleppo and Hims fell into the hands of the Tartars. Soon after, the sultan sent an embassy to the conqueror, with costly presents and offers of amity; and at length peace was established, Fúrreg conceding a large portion of territory. Timúr-lang died in the year A.D. 1405, and the Egyptian monarch, when apprised of that event, was preparing an expedition to recover, if possible, his possessions, when he was surprised in his palace by an insurrection headed by his brother, Abd-el-Azíz, and was compelled to betake himself to flight. The people, supposing he had perished, proclaimed Abd-el-Azíz sultan. In three months, however, Fúrreg deposed him, and enjoyed a peaceful reign, until the Khalífeh El Musta'ín, at the instigation of the Emír Sheykh El-Mahmúdí, boldly declared himself sultan, instituted criminal proceedings against Fúrreg on the plea of the severe tribute he had levied for the conduct of the war with Timúr-lang, and accomplished his death. He was beheaded in the year 1406, and his corpse left unburied.

He bears the character of a cruel, extravagant, and voluptuous monarch.

ON A NEW APPLICATION OF WOOD.

BY JOHN R. JACKSON,

Curator of the Museum, Royal Botanic Gardens, Kew.

THE application of thin shavings of wood, as a substitute for paper or cardboard, has been known for some years, and amongst the stationery shown in the Paris Exhibition of 1867, was to be seen packets of so-called visiting cards which had received the impression from the copper-plate. These cards were cut from thin shavings of sycamore, beech, plane, and similar fine-grained European woods, and evidently took the printer's ink admirably well. Since then I have seen these woods applied to the manufacture of envelopes; but the envelopes made of this material have to be lined with paper for the purpose of strengthening them, else in the folds the shavings would crack; another disadvantage is that in writing on wood the ink always has a tendency to run or distribute itself amongst the fibres, and this would be more especially the case if the envelope should become wet by rain in passing through the post; so that except the novelty of the application, wood has little to recommend it as a substitute for paper in respect of envelope manufacture.

But for the purpose of covering the walls of rooms, wood seems specially adapted. Some short time back I received at the Museum some specimens of the various woods of North America, including walnut, bird's-eye and curly maple, bass wood, rock elm, and numerous others, all cut in large sheets of an uniform thickness. These huge shavings, or veneers, are cut by machinery, and are used in the States instead of paper for covering walls, so that one can have his room encased with real wood at about the same cost as paper. The sheets are cut in lengths of about ten feet, and vary in width according to the diameter of the trunk of the tree from which they are cut; but besides these sheets, which of course have their grain running lengthwise, and which look like shavings from a gigantic plane, veneers equally thin are cut across the grain, probably by some sharp instrument, against the edge of which the trunk is kept revolving. These wood papers are affixed to the walls of a room in a similar way to ordinary paper, the edges, or union of two sheets being hidden by a narrow beading of wood tacked on, which serves the double purpose of retaining the veneer in its place, and also gives to the work the appearance of wood panelling,

Very frequently walls thus hung are rubbed down with oil, which both darkens the wood and brings out the grain.

This application of wood, as well as the machinery for cutting such thin slices is, so far as I am aware, of American origin. It might be adopted in this country with advantage as a substitute for the numerous hideous designs upon the walls of our rooms, which help to make our homes ugly.

ARCHÆOLOGIA.

Among discoveries in mediæval antiquities, we may mention one or two of some interest in the old town of Ludlow, in Shropshire. It is known, from old accounts, that there formerly stood in the lower part of Corve Street an establishment of White Friars, with a church, or chapel, dedicated to St. Leonard; though all outward appearance of this priory had long ceased to be visible. But, during the summer and autumn of the present year, this site has been laid out for the building of a modern chapel, and in digging for it the foundations of the old buildings have been uncovered, and many interesting architectural remains have been found, with the encaustic tiles of the floors. Some of the graves also have been opened, containing the bones apparently of ecclesiastics. It is to be hoped that a careful record has been preserved of these discoveries. In another part of the old town, in a small court adjoining to Castle Street, known by the name of Quality Square, in excavating for the formation of drains, the foundations of buildings have been found, with pavements of encaustic tiles, which would lead us to believe that it was of an ecclesiastical character. It is not improbable that it was a court belonging to the college of St. John, the house of the very ancient and important Guild of Palmers in this town.

The antiquaries of France have been rather active in their researches during the present year. The Abbé Cochet has been vigorously prosecuting researches in the forest of Eauy, and on the line of the new railway from Elbeuf to Sénarpont. In numerous instances Roman villages and towns have been discovered beneath the ground, under woods which have spread over the ruins simply because the land was not deemed worth the trouble of bringing it into a state for cultivation. Two recent discoveries in the forest of Compiègne and at Mont Berney appear to have stimulated the abbé to work in this forest. If the results have not

yet equalled those of M. de Roussy in the places just mentioned, they are sufficiently encouraging. Several houses have been partially explored, in one of which the principal room had been used, after the destruction of the town or village, which had been apparently burnt, as a burial-place. It contained about thirty skeletons, of all ages, male and female, carefully deposited and in regular order, the heads to the west and the feet to the east. Between the legs of three of them were scramasaxes (the Frankish sword) of iron, one of which had two grooves along each side of the blade, and one had been broken in the middle previous to interment. The buckles attached to the belts are damaskeened with silver. There were also four earthen vases and a glass cup, all of which show that these interments are of the early Frankish period. Among the objects discovered during these excavations are two oval weights in basalt, or a hard black stone, mounted with appliances for iron rings, the smaller marked with the figure X and weighing sixteen pounds, the larger weighing thirty-two pounds.

The railway-cutting alluded to, in passing by NESLE-HODENG, brought to light in a field named *Le Paradis* a quantity of vases, hatchets and spears of iron, and some ornaments in brass. The Abbé Cochet, with the aid of M. Semichon, and a grant of three hundred francs from the Prefect of the Seine-Inférieure, soon began systematic excavations on the spot, which were continued from the 5th of October to the 26th with complete success. Six rows of graves were opened, each containing from fifteen to twenty-two inhumations. The rows ran from north to south, while the graves lay from east to west. Unfortunately, as the abbé states, the greater number had been visited and disturbed by treasure-seekers, probably in the Middle Ages. About twenty-five had remained untouched, but these fully repaid the labours of the explorers. The Abbé Cochet remarks that the ancient robbers of the graves knew, as well as we do, that the valuable objects buried with the dead were laid near the upper part of the body, for the ransacked graves show that they rarely disturbed the vases at the feet, or the weapons in iron. Nearly forty vases, in black, white, and red clay, have been saved. Like most of the Frankish and Merovingian vessels, they have ornamental patterns *incuse;* but the Nesle examples are distinguished from those previously known by the peculiarity of having a foot. It was quite exceptional that one grave contained a vase in bronze, and the grave of a young girl contained the remains of three or four Roman vases in pottery and in glass. As usual in cemeteries of this period

iron abounded. Not less than thirty knives were found in the graves at Nesle; one of which has the handle ornamented; another, a sheath of leather decorated with bronze. There were found eight hatchets and four spear-heads, with a small sickle, similar to that found at Dovrend in 1865. Among other objects made of iron were a gimlet, two arrow-heads, the handle and hoops of a bucket, and three clasping mouths of purses. Among objects of bronze were buckles and triangular studs of the girdle, or belt, eight fibulæ of the character called cruciform, and four in the form of birds of prey; and four coins, three of Tetricus, and one perforated for suspension. Contrary to the usual rule, objects in gold were rather numerous, and included seven gold beads, a silver hair-pin covered with gold leaf, a bird-shaped fibula similarly covered with gold leaf, and two magnificent fibulæ of gold and silver, ornamented with red glass and filigree work. There was also found a gold coin of Anastasius, who reigned from A.D. 491 to 518, which was valuable in fixing a limit of date at least in one direction. The objects collected in the course of these excavations will be deposited in the Rouen Museum.

Mr. W. H. Bansted, of Maidstone, has recently obtained from a brick-field near NEW HYTHE, AYLESFORD, a small Roman wide-mouthed vessel, which appears to have belonged to a sepulchral deposit. It is remarkable for having on the exterior surface marks which are considered to indicate the action of salt-water. This could not have been caused by the action of the water of the Medway at the present day, and the question naturally arises whether the flow of the sea up this river in former times was greater than at present. It is proved, by the remains of a Roman building near the church, that at Snodland the river at present flows more to the west than in the Roman times, and it is well known that the sea continues to gain ground below Chatham. We are informed in the Domesday survey, that at that time Maidstone possessed *salinæ*, or salt-works.

T. W.

PROGRESS OF INVENTION.

MANUFACTURE OF PAPER.—M. Charles Alexander Thirion, of Paris, precipitates white substances or dyes upon the pulp before it is made into paper. These white precipitates or dyes may consist of such insoluble precipitates as the insoluble silicates, sulphates, or carbonates of barium, calcium, and strontium, or the insoluble silicates and carbonates of magnesium. The substances selected to form the white precipitates are dissolved separately, and then mixed successively with the pulp. Thus, if sulphate of barium be the precipitate employed, a solution of a salt of barium is first added, and then sulphuric acid, or a solution of a soluble sulphate. The pulp thus prepared is made into paper in the ordinary way.

TIGHTENING PISTON RINGS.—This is accomplished by placing a moveable valve or valves in the body of the piston, which valves are opened and closed by the working pressure (of whatever kind, whether air, steam, water, or other liquids) on either side of the piston, thereby causing a continual pressure (equal to the working pressure on either side of the piston) to act against the inner sides of the metallic rings composing the piston, thus continually pressing them against the sides of the cylinders whilst the engine is at work. The piston may or may not be made without the top or lug ring, and the circumference of the rings may be in one or more parts, and secured by tongue-pieces. The valve or valves may be made either single or double, and placed opposite to each other, or in any position which may be found convenient. The advantages gained by this invention are numerous, but they consist chiefly in simplicity, thus saving labour and expense.

MEASURING LIQUIDS.—The object of this invention is to measure fluids for domestic and manufacturing purposes—so that the quantities used may be registered. In carrying it into effect the liquid is conducted through a pipe into an air-tight chamber, where it is discharged upon an oscillating water way, which guides it alternately into one of the compartments of a double chambered measuring vessel. The quantity of liquid allowed to pass into each compartment, is regulated by adjusting floats upon rods attached to a series of levers. These floats when elevated to their highest point, will be caught and held up by latches extending over rests or catches. During the ascent of the float in the filling compartment a valve opening into the opposite chamber, which is empty, will be closed. At the instant the float in the filling chamber has arrived at its highest point, the opposite float will be released and allowed to drop, in doing which, it will raise a valve in the filled chamber, and at the same time shift the water way so as to guide the liquid into the empty chamber, which latter will be receiving liquid while the opposite chamber is discharging its contents into a small cistern. In this way the measuring chambers will

be alternately filled and emptied, and each measured quantity will be registered by suitable mechanism operated upon by the rack shaft, on which the water way is mounted. The liquid is drawn off from the receiver through a pipe provided with a valve, and controlled by a float, which float is so arranged, that should the liquid rise high enough to obstruct the correct working of the measuring apparatus, it will close the discharge-valve and prevent the liquid being drawn off. In order to close the supply pipe a ball and socket valve is employed, and it is acted upon by the compressed air in the air-tight chamber. Should there not be sufficient air to close the ball valve immediately, extra air may be introduced through a small chamber communicating with the external air, the admission to and the discharge of the air from it being controlled by suitable taps.

Ventilating Tunnels.—Mr. John Ramsbottom of Crewe, has invented a method of ventilating railway tunnels. The invention consists in extracting the vitiated air from the tunnel through one or more openings, at or near the middle of its length by means of fans, pumps, or by the rarification of the air by heat in an upcast shaft, as is practised in mines; the vitiated air so exhausted being replaced by fresh air from each end of the tunnel. In cases where the vitiated air cannot be extracted sufficiently near the centre of the tunnel the velocity of the currents from each end may be regulated by screens or other equivalents attached to the sides of the roof of the tunnel.

Lawn Mowing Machines.—Mr. F. W. Fellows and Mr. John Bate, of Manchester, have patented the following improvements in mowing machines. They consist in a new mode of giving motion to the knife-barrel shaft of lawn-mowing machines, and to effect this, in one of the travelling or supporting wheels is made an internal spur or bevel gear, and on the same end of the knife barrel shaft is keyed a small pinion which gears into, and receives its motion from the internal gear or wheel in the travelling wheel, the same result may be obtained by friction rollers; by these means the back roller, now in use, may be dispensed with. The box for receiving the cut grass may also be placed at the back instead of the front of the knife barrel shaft, as is now customary, or it may be altogether dispensed with.

Horse-shoes.—This invention includes certain novel combinations of metal and India-rubber or other elastic or flexible substance, and its most distinguishing features are that the metal portion of each shoe is made in one piece, and the India-rubber combined with it is so fitted that it projects slightly beyond the metal on the treading surface, and so serves as a cushion; and consists, firstly, in constructing the metallic portion of a shoe, adapted to be attached by nails to the hoof, or in any other manner, with one or more grooves on the treading side, and in fitting in them a piece or pieces of India rubber or other elastic materials; secondly, in constructing the metallic portion of a shoe with a treading ridge or

surface, and a flat inner web, and in combining with it India-rubber—in such a way that it surrounds and is in contact with both the flat sides, and also the inner edge of the web. The India-rubber is carried between the metal portion and the hoof, so that the fastening nails pass through it. To prevent these shoes from becoming loose, the India-rubber—which interposes between the shoe and the hoof, is made of sufficient hardness to obviate lateral working, and prevent sand from reaching the sole of the foot, and so prevent balling, and for other purposes; when necessary, the India-rubber is formed so that it extends backwards and fits close to the base of the frog of the foot.

Reverberatory Furnaces.—The improvements in furnaces of this class are numerous, those of Mr. Francis Dinon Nuttall, of St. Helen's, seem to be extremely good. They consist in the construction of reverberatory furnaces with a combination of a thin partition wall formed at the back of the fuel chamber, so that there is left between the partition and the fire bridge a passage for the regulated admission of air upwards, to mingle with the gases, which are evolved by combustion and to promote combustion. There is also an opening at the side, or at both sides of the furnace, near or at the end of the fire bridge, so that any deposit or stoppage of the before-mentioned passage may be easily removed. These openings are closed by valves when the furnace is at work.—A means also for supplying heated air is devised so as to promote combustion. For this purpose tubes of fire clay are led from the front of the furnace, backwards, towards the back of the furnace, where they terminate. There are ledges placed along the sides of the furnace to support these tubes.

Velocipedes.—Mr. William Wallington Harris, of St. John's Wood, proposes to obtain greater speed in velocipedes, and to lessen the amount of power employed, in the following manner:—The mechanism consists of one or more toothed wheels or other gearing attached to the driving wheel, and geared with one or more wheels attached to the crank, in a manner somewhat similar to the arrangement known as the sun and planet wheel. The crank pin being prevented from turning on its own axis by radius or sliding motion-bars.

Manufacture of Soda and Potash.—M. François Marie Bachet, of Paris, has discovered a new method of obtaining soda and potash, from the chlorides of sodium and potassium. Either of these chlorides is decomposed, in the presence of water and at the ordinary temperature, by oxide of lead. By the decomposition is formed oxychloride of lead; or more correctly speaking a mixture of chloride of lead and hydrated oxide of lead, and also caustic soda or potash. These latter are in solution, the former are solid. When the oxychloride of lead is boiled with lime, of course in the presence of water, the oxide of lead is brought into a condition suited for again acting upon fresh chloride of sodium—for oxide of lead and chloride of calcium are formed, the calcic chloride

is useless. These two reactions combined may be so employed that an indefinite quantity of sodic chloride may be decomposed and sodic hydrate formed.

LITERARY NOTICES.

THE LITERATURE AND CURIOSITIES OF DREAMS: a Common-Place Book of Speculation concerning the Mystery of Dreams and Visions, Records of Curious and Well-Authenticated Dreams, and Notes on Various Modes of Interpretation adopted in Ancient and Modern Times. By Frank Seafield, M.A. Second edition, revised. (Lockwood and Co.)—Mr. Seafield's book is exactly what it pretends to be, and very well done. It is a well-compiled and edited "Commonplace Book" on the curious subject of which it treats. The author has evidently taken a great deal of pains to consult a large range of authorities, ancient and modern, and his book will not only please those fond of wondrous stories, but will be useful to any student of the philosophy of the subject. Being a second edition, we need not say more.

OUR OWN BIRDS: a Familiar Natural History of the Birds of the United States. By William L. Bailey. Revised and edited by Edward D. Cope, Corresponding Secretary of the Academy of Natural Sciences. (Lippincott and Co., Philadelphia; Trubner and Co., London.)—A nice little popular work, prettily illustrated and pleasantly written. It forms a good introduction to the study of ornithology. The author has made extensive use of Wilson, Audubon, and other known authorities, and has arranged his matter in a simple and interesting way.

AS REGARDS PROTOPLASM IN RELATION TO PROFESSOR HUXLEY'S ESSAY ON THE PHYSICAL BASIS OF LIFE. By James Hutchison Stirling, F.R.C.S., LL.D. (Edinburgh, Blackwood and Sons.)—Mr. Hutchison is one of the innumerable assailants Professor Huxley has brought upon himself by his assertions with respect to the physical basis of life, and the greater part of the paper now published was delivered, as its author tells us, as a lecture at a conversazione of the Edinburgh College of Physicians. We certainly shall not attempt the task of defending Professor Huxley. He is well able to take care of himself, and would make mincemeat of such opponents as Dr. Stirling; albeit, he has, in our opinion, talked too fast, and not kept prudently within the limits of the known. Calling protoplasm a physical basis of life gives no real knowledge. The mystery is just where it was, and Professor Huxley has done nothing whatever to solve it. Dr. Stirling discourses of various person's opinions, but adds nothing to the elucidation of the subject. The protoplasm discussion is already a bore.

MR. PROCTOR'S STAR MAPS.—Mr. Proctor, B.A., F.R.A.S., has planned a new star atlas, which seems to possess a number of good qualities not hitherto combined in a series of star maps. There will be a moderate number of maps of convenient size, yet the scale will be nearly that of a twenty inch globe. All the maps (there are to be twelve) will be equal in size, similarly projected, and symmetrically disposed with respect to the celestial sphere. There will be no appreciable distortion, even at the edges—a novelty in star-mapping; and by causing each map to slightly overlap its neighbours, there will be none of that annoying interruption of star groups which is so inconvenient to the observer. About 6000 stars (every star, in fact, down to the sixth magnitude inclusive) will be taken from the well-known catalogue of the British Association, and 1500 objects of interest—double stars, nebulæ, variables, and so on, are to be added. New modes of indicating the names of constellations, and the character of different objects, will serve to render the maps less crowded than by the old arrangement. The Greek letters and Flamsteed's numbers even are to be put in after a new style, without hair-lines or flourishes, and with direct reference to the wants of the observer. A new and exceedingly simple way of indicating the effects of precession (by small arrows placed on the latitude-parallels) is to be adopted, in place of the mysterious triangle in the corner of the old-fashioned maps. The constellation-figures are to be omitted in the principal maps; but to make up for the omission, Mr. Proctor's twelve gnomonic maps, in two large sheets, are to be added as index-plates. The work is to be photolithographed by Mr. Brothers, of Manchester, and is to be published by subscription.

OUTLINES OF CHEMISTRY; or, Brief Notes of Chemical Facts. By William Odling, M.D., F.R.S., Fellow of the College of Physicians, Vice-President of the Chemical Society, and Fullerian Professor of Chemistry of the Royal Institution. (Longmans.)—The title of this book may delude many students into purchasing a work quite different from what they expect, and of no earthly use to them. Dr. Odling, as he states in his preface, has thrown together the notes from which he lectured for seven years at St. Bartholomew's Hospital, and in no rational sense can they be termed "Outlines of Chemistry," or, indeed, "Outlines" of anything. They are an illogical jumble of statements of fact and theoretical hints, and without an index to guide any reader to what he might require. A few quotations will show the value of this curious publication. The first heading is "Elastic Fluids," and the first passage is—"Material objects viewed in relation to their composition. Recognition of the different kinds of matter of which all bodies are constituted. Comparison of physical with chemical changes. Special references of chemistry to changes in the composition or identity of bodies. Consequent developments of motion, heat, and electricity." Now, unless we selected a paragraph from Dr. Odling's lecture on carbon, we do not know where to find any-

thing worse than what is here just cited. There is no special connection between "elastic fluids" and viewing material objects in relation to their composition; elastic solids and non-elastic ones admit of just the same consideration. "Recognition of different *kinds* of matter, of which *all* bodies are constituted," is simple nonsense. In the first place, how does Dr. Odling know that *all* bodies are composed of different *kinds* of matter? If he has made such a discovery, he should explain it. In the next place, has he any method of recognizing those alleged "kinds of matter"? Probably, when he spoke of *kinds* of matter he meant states of matter, and he may have intended to discourse on the different states which matter assumes. We know matter under different forms, but we do not know whether more than one *kind* of matter exists.

The special reference of chemistry to changes, etc., has no more to do with "elastic fluids" than with any other bodies; and no one not acquainted with Dr. Odling's singular capacity for misarrangement, would look for an explanation of the metric system of weights and measures where he puts it, under the head of "elastic fluids"!

Having begun his "Outlines of Chemistry" with a chapter on "elastic fluids," such as we have shown, the second chapter of this curious book is on "symbolic notation," unintelligible to a beginner, and of no use to an advanced student. Then comes "law of volumes" and "atomic weights," subjects which cannot be explained until a good many facts are known, and which Dr. Odling's explanations will not suffice to make clear. Here, as usual, we notice his tendency to illogical methods, for, under the "law of volumes," we find "nature of ordinary combination," and "presence of water, or moisture in the air, shown by its condensation on cold surfaces;" and under "atomic weights" we come to "distinction between intensity of heat or temperature, and quantity of heat."

The fifth chapter is on "equivalency," and begins with the words "Classification of primary hydrides into mono- di- tri- and tetra-hydrides." In lecturing, Dr. Odling may lead his pupils gradually up to those matters, but in his book there is no explanation of the things necessary to be known before such words as we have cited can convey any meaning.

The sixth chapter is on "acids and salts," and we are told that "bodies of which the hydrogen is easily replaced by metal [are] classed as acids." The term acid has long since become merely conventional, not necessarily including the notion of sourness, and chemists are not agreed as to bodies which should be comprehended under it. We do not think, though many chemists are in its favour, that the view adopted by Dr. Odling will ultimately prevail.

We do not know what Dr. Odling means by stating, in chapter eight, "potential energy of zinc and other metals *derivable* from potential energy of carbon." In what way does he imagine carbon to bestow their potential energy upon such bodies?

In chapter nine, devoted to hydrogen, we find mention of "its abundant existence in the *form* of *water*." Hydrogen does not exist in the *form* of water, but a certain compound of hydrogen and oxygen is water, which is quite a different thing. One chapter is headed "halogen hydracids," which would suggest that there are acids which are not hydrogen acids, although by the theory espoused by Dr. Odling all acids have that character, notwithstanding which he proceeds to describe halogen oxacids. If chemists should, which is not likely, ultimately agree to call nothing an acid which does not contain hydrogen, there would be no use in retaining the term hydrogen acid or hydracid, though oxacid might still be required to designate those in which oxygen was a constituent. When Dr. Odling comes to sulphuretted hydrogen (H_2S) he calls it sulphydric acid; but if the view he accepts be adopted, it should be sulphuric acid to be consistent in nomenclature.

If Dr. Odling called his book "Rough Notes of Lectures," its general character would have been understood. He says in his preface that "it is not intended for study itself, but as a companion to the teachings of the lecture-room; and as an aid to the appreciation of more complete works, such as Miller's Elements and Watts' Dictionary." His own pupils might find it of some use; those who attend other lecturers will not be assisted by it, and as an aid to the appreciation of more complete works it can only be effective in the same way as a bottle of bad wine may assist drinkers to appreciate good. Dr. Odling has reached a position which will give his books a sale, until their quality is understood; but he should not take advantage of his luck in this respect to put forth things destitute of real merit, and quite unworthy of the powers his friends believe him to possess.

NOTES AND MEMORANDA.

External Gills of Ganoid Fishes.—According to "Comptes Rendus," M. F. Steindachner discovered, in a recent voyage to Senegal, two fishes with the above character in their young state. In *Polypterus Lapradei*, external gills are found in individuals about nineteen inches long. They consist of a flattened band, with fringed borders, very analogous to the external gills of axolotl; but there are not three, only one on each side behind the operculum, and extending beyond the posterior margin of the pectoral fin. In *P. Senegalus*, this transitory organ disappears more promptly, and is only in specimens three or four inches long. The author asks if the Polypterus of the Nile, discovered by Geoffrey St. Hilaire, possesses a similar accessory apparatus of like limited duration. The Squalidæ, the rays, and the paradoxical African fish, *Protopterus anguiliformis*, are they not the only ones furnished with external branchia?

The August Earthquakes in Peru.—M. Gauldrée Boileau states that on the 15th of August between 4 and 5 a.m. at Tacna, and Arica on the night of the 20th and 21st of August, between 10.30 and 1, fresh earthquake shocks were felt. At Tacna and Arica,

they were very strong, characterized by an undulatory movement from east to west, and accompanied by subterranean noises. Many inhabitants left their homes and resorted to tents. Yellow fever has re-appeared in some localities, and the people fancy this epidemic is connected with the earthquake. At Lima, shocks were felt from the 20th to the 24th of September, and the sea retreated and returned five times at Iquique. In 1868, however, the yellow fever made great ravages six months before the earthquake came, and therefore could not have been caused by it.

Use of Arsenic in Insanity.—According to "Cosmos," Dr. Lisle has employed arsenious acid with great success in certain cases of insanity.

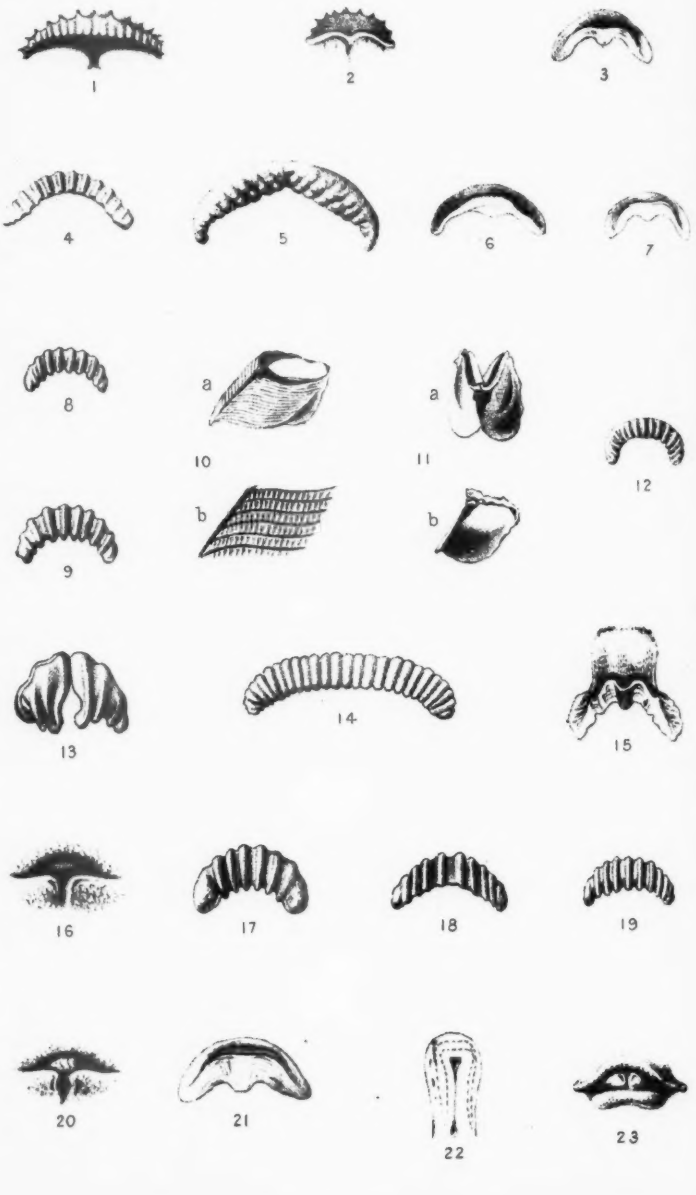
Antidote to Tobacco.—Properties of Oil of Sassafras.—The "Canadian Pharmaceutical Journal" contains a letter from Dr. Shelby, quoting a work published some years ago, by Dezin Thompson, Nashville, Tenessee, on Fever, on the action of oil of sassafras on tobacco, and confirming it by his own experiments. It is said that putting a few drops of oil of sassafras on the end of cigars, or on the tobacco in the pipe, acts as an antidote to the nicotine. If used with a pipe a little dry tobacco should be put over the wetted portion. According to Dezin Thompson, oil of sassafras counteracts hyoscyamus, and destroys the poison of insects, such as mosquitoes, fleas, spiders, etc., and it succeeded against the venom of the copper-headed snake.

Structure of Fish Scales.—According to Dr. Salby ("Archiv. für Anat. and Archives des Sciences"), the mucous feel of a fish does not arise from a mucous secretion, as affirmed by Agassiz, but from the character of the epidermis of the scale as shown by Leydig, which keeps soft and absorbs water. Dr. Salby demonstrates that the striæ of ctenoid and cycloid scales are due to a series of irregular crests, all belonging to the superficial layer of the scale. The lower and much thicker layer is formed of a series of superposed laminæ of two substances. The thickest laminæ are colourless and brilliant; the thinner, yellowish, and slightly transparent. The first are calcareous, and the second formed of a kind of cement destitute of lime-salts. The calcareous layers are thicker in old than in young specimens. A periodical deposition of lime-salts takes place in that part of the corium which is immediately applied to the inferior surface of the scale, and after a time a layer of cement is deposited between the laminæ and the corium. This alternation is repeated many times.

Sonorous Bronze.—M. A. Riche informs the French Academy that, to form sonorous instruments of bronze, they should be hammered hot, as M. Dumas says the Japanese Encyclopedia prescribes. From experiments in the Mint at Paris, it appears that alloys, consisting of 20 tin and 80 copper, were run out into bars which contained from $18\frac{1}{2}$ to $21\frac{1}{2}$ per cent. of tin. When cold, these bars were brittle under the hammer; about 300° or 350° (C) a sensible improvement was noticed, and at a dull-red heat they could be beaten out into thin sheets, which were very sonorous.

Creosote in Typhoid Fever.—According to "Cosmos," the experiments of M. Pecholier and Dr. Gaule show that this substance is a successful antidote to the poison of typhoid fever, curing ten out of twelve cases. The cause of the fever is ascribed to microscopic organisms.

Royal Exhibitors.—The King of Cambodia, and the Queen of the Sandwich Islands, have received honourable diplomas from the Exhibition of Altona, the one for drugs, and the other for woven fabrics from their respective countries.



MANDIBLES OF GASTEROPODA.

ON THE MANDIBLES OF LAND AND FRESH-WATER GASTEROPODA.

BY RALPH TATE, ASSOC. LIN. SOC., F.G.S., ETC.

(*With a Plate.*)

In a paper on the Dentition of Gasteropods, published in the INTELLECTUAL OBSERVER, vol. v., p. 67, the author points out the part that the dental apparatus plays in the economy of these mollusks, and its value in systematic classification; for, by the characters afforded by this organ, the zoologist is enabled to determine the genus to which any snail belongs, and even to separate species of the same genus. On the whole, the dental pattern is of generic value, whilst the numerical strength of the rows and teeth is a differential character for the species.

However, another organ—the first that we become acquainted with, and therefore has a prior claim to our notice, in examining the digestive system of a gasteropod—is of nearly as great a value as the *odontophore* (or so-called tongue) in determining species and genera. This organ is the *mandible*, or so-called jaw, to which Moquin-Tandon attached so much value as to propose its employment as a basis of classification. M. Mörch has, in more recent times, so made use of it, and other macologists have, to a greater or less extent, so employed it. Though I am not disposed to yield so much importance to the mandibular apparatus, yet I am fully aware that it has not received that attention with a view to the elucidation of the affinities of genera and species, it seems to deserve; because, perhaps, it is not so available as many other parts of the animal for this purpose. Still, the investigations that have been made enlarge our knowledge of the affinities of gasteropods, though not to the same extent as those on the lingual dentition. But when once we have ascertained the natural position of a genus, the relations of which are otherwise somewhat doubtful, it is surprising how the characters of the shell, perhaps misunderstood before, concur to bear out the affinities indicated by the mandibular armature and by the teeth.

I would claim for the mandibular organs a diagnostic value in the systematic arrangement of slugs and snails, and the description of the jaw should be added to that of family and genus. Among our slugs the species of *Limax* can be readily confounded only with those of the genus *Arion*, but they can be at once distin-

guished by their smooth arcuate jaw with its rostriform median projection, that of *Arion* being ribbed and regular concave. (Compare Figs. 3 and 4). So again *Succinea oblonga* and *Limnæa truncatula*, species outwardly similar, though belonging to different families, may be distinguished by the form of the mandibles; in *Succinea* the jaw is single, arcuate, and rostrated, but with a posterior plate, whilst the mandibular apparatus of *Limnæa* consists of three pieces. (Compare Figs. 15 and 16). Not only may genera be separated by the mandibular characters, but also closely-allied species—assuming that the form and ornamentation of the organ are constant for each species, and, so far as we know, this is the case. A slug which I discovered in Central America, and described under the name of *L. meridionalis*, so much resembles *Limax agrestis* of our gardens and fields, that I could not refrain from assigning it to that species, though so extensive a geographical range was opposed to such a view, till an examination of its anatomy determined its specific distinctness; and most prominent among the differential characters is that of the mandible. (Compare Figs. 3 and 7).

The mandibles of snails have another value, their minuteness, variety of form, and ornamentation, at once place them within the domain of the microscopist.

Before proceeding to a systematic examination of these organs, it would be well to answer the following questions that will be asked by those unacquainted with the structure of a gasteropod; these are—What is the nature and use of the mandible, and how is it to be examined and isolated from the animal?

Let us take for our first victim the large black slug (*Arion ater*) so common in our gardens and borders of fields. Having obtained our slug, we put an end to its existence by immersing it for a few seconds in a solution of corrosive sublimate, or benzole. If this be carefully done, while the animal is in motion, very little contraction will have taken place, and the structures will be found in possession, more or less, of their normal characters. The head may now be cut off and pinned down—in such a position as to bring the mouth of the slug in full view—to the bottom of a gutta-percha dissecting trough, containing sufficient water to cover the subject. The opening of the mouth is seen to be bounded by fleshy contractile lips; the majority of authors distinguish three, a superior one, which is more or less arched, and two inferior and sub-lateral ones, which are somewhat angular; these latter may be considered as two parts of a lower lip, divided by a vertical slit; viewed in this way, they may be conveniently termed labial lobes.

(See Fig. 1, which represents the contracted mouth of *Arion ater*, and Fig. 2, that of *Limax Sowerbyi*, the jaw is seen in the opening.) The edge of the upper lip is crenulated or puckered, so as to present a row of eight-rounded papillæ. External to this fleshy lip in *Bulimus oblongus*, there is a single series of tentacular appendages, in the form of a fringe, which recall to our minds those of *Nautilus*; no such structure is exhibited by any of the British slugs and snails.

Within the oral orifice, and attached to the inner surface of the upper lip is a horny yellow crescent-shaped beak or mandible, that part of it which is implanted in the lip is very large relatively to the organ itself, but this is not always the case. From the inner lower edge of the beak there proceeds a thin membrane which lines the roof of the mouth, becoming attenuated posteriorly and on each side; in *Limax Sowerbyi*, it is distantly striated, but is smooth in the other mollusks observed. I am not aware if this structure has before been described. The jaw is composed of chitin, and contains a slight quantity of carbonate of lime. In *Ampullaria* (*Pomus*) *urceus*, the tips of the beaks are quite calcified.

The natural food of the majority of snails is vegetable, and the formation of the mouth, and the organs with which it is armed, seem to be peculiarly well adapted for cutting and reducing fruits and succulent leaves. The beak is opposed by the divided soft lip below, and plays the part of a mandible in grasping the substance to be eaten, whilst the odontophore (or horny tongue) which occupies the floor of the mouth, rasps off, and carries into the mouth the pulpy nutriment. This operation is carried on with great rapidity, and the substance to be eaten soon disappears; and if against a chip-box by an imprisoned large slug or snail, a grating noise is distinctly audible.

The beak can easily be detached from the lip by the aid of a needle. It may be washed in potash to remove any fleshy matter that may adhere thereto, but it must be well cleansed in water before mounting. The beak can also be obtained by boiling the head of the mollusk in potash, taking care to use the necessary precautions. My usual plan with the larger snails and slugs, if the beak is only wanted, is simply to kill the mollusk by boiling water, grasp the head between the fingers, interposing a cloth rag to prevent its slipping, then to apply a requisite amount of pressure, so as to exsert the muzzle and to bring the beak well forward—a needle does the rest.

An examination of the beaks of the majority of the small species may be instructively made on the living animals, for in those in

which the flesh is white (as in *Carychium minimum*, *Helix pulchella* etc.,) and more or less transparent, the beak can readily be discerned through the tissues, which not unfrequently contrast strongly in colour with the jaw, and which is usually fawn or brown, sometimes light orange or reddish-brown, and at other times yellowish or pale amber, the shade deepening towards the exposed edge. The colour is constant for each species, but variety of colouration is met with among species of the same genus; thus, in the pond-snails, that of *Limnæa palustris* is a brown-black, that of *L. auricularia* is fawn, while that of *L. trunculata* is amber.

With regard to the size of the jaw, there is necessarily great variation in the several species, but it is more or less proportionate to that of the animal; in *Bulimus oblongus* it is 0·32 inch long and 0·1 inch broad; in the larger British slugs and snails, its length is from one-fifth to one-eighth of an inch, and its width one-eighth to one-tenth; in *Bulimulus montanus* the length is 0·8 millimetres; in *Cochlicopa subcylindrica* and *C. tridens* it is from 0·33 to 0·5 millimetres, and in the small *Pupæ* and *Carychium* of proportionately less dimensions.

Though the majority of snails live on a vegetable diet, yet it is certain that some species are also fond of animal food, and sometimes prey upon earthworms, their own eggs, and even upon each other. These predaceous molluscs are characterized by having numerous slender teeth, conical and distant, and by the absence of a mandible, they belong to the genera *Glandina* of tropical and subtropical America, *Testacella*, British and European, and *Daudebardia*, Central Europe. Other beakless forms are *Cylindrella*, *Streptaxis*, *Helicina*, *Peronella*, and *Onchidium*, which last only is represented in Britain.

Among the terrestrial and fluviatile gasteropods, the mandibular armature is organized after three types:—

First. That of a single beak; as in the black slug *Arion ater*, common snail (*Helix aspersa*), and the other land slugs and snails, possessing mandibles; and the majority of the fluviatile inoperculate pulmonifera.

Second. That of three pieces; consisting of a large superior beak, and two small lateral ones, as in the pond-snails (*Lymnææ*).

Third. That of two mandibles; implanted laterally as in *Cyclostoma*, and in all the operculate pulmonifera (excepting *Helicina*, which is unprovided with jaws) and in the fresh-water gasteropods; as *Neritina*, *Paludina*, etc.

In the SINGLE-BEAKED TYPE, the organ is always attached to the

upper lip, and represents the mandibulary system of the pond-snail, less the lateral pieces; its form is usually more or less arcuate, and is smooth, striated, or corrugated. A variation in form, structure, and ornamentation, has necessitated a further subdivision into the following groups :—

I.—Rostriform mandible. This form of jaw is typified by that of *Limax* (Fig. 6 which represents that of *L. Sowerbyi*) in which the organ is strongly arched from before, backwards, smooth, usually neither striated nor costated, and provided with a vertical ridge projecting with more or less prominence in the form of a blunt beak beyond the free border.

Grouped with *Limax* are the genera *Helicella, Vitrina,* and *Macrocyclis,* and the close relationship of these genera is thus strengthened by the similarity in the mandibular organ. The slugs (*Limax*) are connected through *Vitrina* with the true snails (*Helices*). The lingual dentition of these genera which constitute the sub-family *Vitrininæ,* presents the following characters, and is moreover confined to them, and to the sub-family *Zonitinæ* :—Each transverse row is composed of a central tooth and many laterals, which change their form as they approach the margin; being at first tricuspid, then bicuspid, are finally simple cuneiform teeth with more or less recurved acicular apices. The sub-family Zonitinæ comprise various genera allied to *Helicella,* by the character of the shell, jaw, and lingual dentition, but differ in the presence of a caudal mucus pore. The strictly American genus of slug (*Tebennophorus*) is characterized by a rostriform jaw, and the lingual dentition approaches that of *Limax.*

Though this form of beak is usually smooth, yet in some species it is centrally somewhat striated; in a few American species of *Helicella,* the free margin is notched on each side of the rounded median projection.

II.—Rostriform with a posterior plate. The amber snails (*Succineæ*), which are allied to the pond-snails in form and somewhat in habits, as also in some respects to *Limax* and *Helix,* have mandibles that present a remarkable peculiarity. The organ is clearly of the type we have just considered; in form, it resembles a horse-shoe, for it is strongly arched, and the two extremities are elongated, and descend nearly vertically; the beaked projection is very marked, but its peculiar character consists in the plate which surmounts it, and by it is attached to the cavity of the mouth, this addition to the beak is high, broad, and of a quadrangular form (see Fig. 15).

Recent investigations on the buccal apparatus, including odontophore and plate, have necessitated unlooked-for changes in the systematic position of many genera, and not more striking examples can be quoted than those which are now arranged in the sub-family *Succininæ*; it is comprised of the following:—

1.—Animal completely retractile within the shell:—*Succinea*; world wide; *Simpulopsis*; Central and South America, Hayti, Porto Rico, and Trinidad.

2.—Shell covering only a portion of the animal. *Omalonyx*; Dominica, Bolivia, Juan Fernandez.

3.—Animal limaciform; shell enveloped in the mantle. *Hyalimax*; Bourbon, Mauritius.

4.—Animal limaciform; shell absent or rudimentary. *Athoracephorus* (syns. *Janellia, Aneitea, Triboniophorus*); Australia and neighbouring islands.

III.—Beak-furrowed. This group embraces most of the genera of terrestrial pulmoniferous snails, and many of the fresh-water forms. The mandible is characterized by being slightly curved, not carinated as in former groups, and usually ornamented anteriorly with more or less vertical and parallel striæ. The striations when present are numerous and serrated, and are often so fine as only to be discerned by the aid of a high magnifying power; these striæ correspond sometimes with the denticulations of the margin, but these latter are not very perceptible. The middle of the free border of the beak is more or less produced, but never acquires the character of a rostrated process.

The following British forms possess mandibles of this type:—

Family *Helicidæ*, some species of Helix, as *H. rupestris, H. rotundatus, Bulimus, Cochlicopa, Pupa, Vertigo, Balia, Clausilia*; family *Auriculidæ, Carychium, Auricula*; family *Lymnæidæ, Physa, Aplexus* (the jaw of *Physa fontinalis* is to be distinguished from that of *Aplexus hypnorum* by being chevron-shaped, whilst in the latter it is strongly arched and narrow), *Amphipeplea*, and *Planorbis*, excepting *P. corneus*, in which there are rudiments of lateral jaws, but all the other species have only one which is superior but strongly crescent-shaped, and may be considered as resulting from the fusion of the three pieces.

IV.—The term tooth-jawed may appropriately be applied to the next group, because the prominent character is in the strong denticulations or crenulations on the cutting edge; these are produced by the more or less vertical and parallel ribs which ornament the surface. Some variation in the curvature of the beak and in the

strength of the ribs may be noted. Thus in one section the mandibular organ is but slightly arched, but the ribs are numerous and depressed, bluntly denticulating or crenulating the margin (see Fig. 12). The British forms in this sub-group are: *Arion* and *Helix* (section *Fructiola*). In the other section, the jaw is crescentic, the ribs are less numerous, but prominent, producing strong teeth on the free edge. This form of mandible is well exhibited by *Bulimus oblongus* (Fig. 18), and among British snails by *Helix pomatia* (Fig. 19), *H. aspersa* (Fig. 8), *H. nemoralis*, *H. hortensis*, and *H. arbustorum*; it characterizes *H. ericetorum*, *H. pisana*, *H. caperata*, *H. virgata*, *H. lapicida*, and *Bulimus acutus*.

The number of distinct ribs varies usually from five to eight, but in *H. arbustorum* there are only four, and in *H. pisana* but three. When few in number they are large and distinct, whilst on the contrary, the more numerous the ribs the less prominent are they. Fig. 9 represents the beak of a young *Helix aspersa*; here only four ribs are developed, but in Fig. 8, which represents that of an adult of the same species, eight ribs can be counted. Multiplied observations have established, as a general rule, that the mandibles of young snails have fewer ribs than those of the adults; their number is augmented by additions to the extremities. Moreover, aged individuals of some species develop accessory ribs in the intervals of the first-formed ones; these, however, are generally not very prominent. In the majority of the *Helices* the ribs diverge a little towards the summit, but in a few species as *H. lapicida* and *H. pomatia* (Fig. 19) they are vertical.

The denticulations vary in prominence and regularity; usually, from the slight obliquity of the ribs, they are directed towards the middle of the mandible, their number corresponding with that of the ribs. In *H. aspersa* (Fig. 8), as also in *H. nemoralis* (Fig. 17), and *H. Pisana*, the denticles are prominent and pointed; whereas in *H. ericetorum* they are so blunted as to resemble rather crenulations than teeth.

V.—Mandible composite; that is, composed of numerous imbricated segments. This form of jaw is not possessed by any of the European gasteropods, and is confined to a few genera only. Fig. 5 represents the mandible of *Orthalicus undatus*, Brug., an inhabitant of tropical America, it is semi-lunar in shape, composed of twenty-one semi-triangular, free, imbricated plates, crenulated on the external free side. The only mandible hitherto described in this genus is that of the allied species *O. zebra*. *Achatina virginea* possesses a similar mandible, so also the species of the genus

Macroceramus, and *Punctum minutissimum* (sp. unique), which having a shell bearing the usual characters of *Helicella*, is generically separated by the nature of the lingual dentition and the composite character of the mandible. Mr. Guppy describes the mandible of *Tornatellina lamellata* as "somewhat horseshoe-shaped, apparently composed of a number of pentagonal prisms laid obliquely, resembling the shell-structure of Brachiopoda."

Let us now proceed to the examination of the second type of mandible that is met with among some of the fresh-water air-breathing snails. It consists of three smooth pieces; one, the true mandible, is large and transversely oblong, or ovate, implanted on the upper lip; the two others are small, often imperfectly developed, narrow, convex, and are placed vertically one on the right and the other on the left of the mouth. The lateral pieces are nearly obsolete in the horny coil snail (*Planorbis corneus*). The other three-jawed snails comprised in the British fauna belong to only two genera *Limnæa* (excluding *Amphipelea*) and *Ancylus*, or the fresh-water limpets. In *Limnæa* (Fig. 23) the pieces are smooth, the superior one is transversely oblong, slightly curved from before backwards, and presents near the middle a broad and obtuse projection, which is especially marked in *L. palustris*; the laterals are very small, convex on their outer faces, and are narrower, less stout and hard than the true mandible. The mandibular apparatus of the common fresh-water limpet (*Ancylus fluviatilis*) Fig. 22, presents the appearance of a horse-shoe and that of a single jaw, but the two lateral pieces are united at their extremities to the superior piece, the free edges of which are slightly convex. Under a high magnifying power the surface of the organ is seen to be roughened with papillæ, which are usually disposed in two rows on the upper piece and in three on the laterals; those on the edge forming as it were a series of denticulations. The jaws are thin, flexible, semi-transparent, and of a brownish colour. Moquin Tandon says, that "during mastication the upper mandible is not brought into play at the same time as the laterals." All the numerous species of *Limnæa* and *Ancylus* inhabiting the continent of North America possess mandibles having the characters proper to the genus to which each severally belongs.

The third type of mandibular armature consists of two lateral pieces approaching superiorly, diverging, and usually dilating inferiorly. They have been erroneously compared with the beaks of the cuttle-fish, which move vertically, like those of a bird; but I

regard them as the two symmetrical halves of the soldered pieces composing the mandible of *Ancylus*. This form of mandible is possessed by all the operculate pulmonifera (excpting *Helicina*, in which the jaws are absent), and in this particular exhibit unmistakeable affinities with the marine gasteropods, the majority of which, as well as those of fresh-water, have mandibles closely resembling them.

The bilateral form of mandible is shown in Fig. 11, which represents the jaws of *Pomus urceus*, collected in the river Yuruari, in Venezuela-Guyana; each piece is sub-quadrate, smooth, with a shelly tip; the inner edges of the jaws in apposition, are united by cartilage; the large bases are placed far within the cavity of the mouth, whilst the somewhat beaked extremities are advanced to the front.

The mandibles of the British fresh-water Gasteropods are but miniature representations of those of the *Ampullaria* (*Pomus*) figured. In fact, this form, and general unornamented character, largely prevails throughout the whole of the fluviatile Gasteropoda; but in *Neritina* (*N. fluviatilis*, is the only British example), the margins are denticulated.

In the Operculate pulmonifera, the mandibles are more beak-shaped than in the fresh-water Gasteropods, but are similarly situated and united by cartilage. The mandibles of a very few species have been observed by me, or, indeed, by any one; those of *Cyclotus Dysoni* (Fig. 10), from Nicaragua, are covered with fine denticulations in regular divergent rows. Mr. Guppy describes the same ornamentation for *C. translucidus;* but it is not exhibited by the sole British representatives of the Operculata (*Cyclostoma elegans* and *Acme fusca*).

Synopsis of the genera of British land and fresh-water Molluscs, grouped according to the nature of the mandibular organ.

I.—Agnatha (without mandibles). *Testacella.*

II.—Monognatha (mandible single).

1. *Oxygnatha.* Mandible lunate, smooth, rostrated. Limax, Vitrina, Hellicella.
2. *Elasmognatha.* Horseshoe-shaped, with a plate behind. Succinea.
3. *Aulacognatha.* Sides nearly parallel, striated. *F. Helicidæ*, Bulimulus (excluding *B. acutus*), Cochlicopa, Clausilia, Balia, Pupa, Vertigo, Cionella, Helix, Section Delomphalus (*H. ruspestris, H. pygmæa, H. rotundata*), Section Vallonia

(*H. pulchella*); *F. Auriculidæ*, Auricula, Carychium; *F. Limniædæ, PHYSA, APLEXUS*, Planorbis (excluding *P. corneus*), Amphipeplea.

4. *Odontognatha.* Ribbed, margin denticulated or crenulated.

(*a.*) Slightly arched, ribs numerous, bluntly denticulate margins. Arion, Geomalacus, Helix.—*H. obvoluta*, section Fructicola (*H. cantiana, H. carthusiana, H .sericea, H. hispida, H. concinna, H. rufescens*), *Bulimulus acutus.*

(*b.*) Strongly arched, ribs few. Helix (section Xerophila) *H. ericetorum, H. pisana, H. caperata, H. virgata;* (section Tachea) *H. nemoralis, H. hortensis*, (Pomatea) *H. aspersa, H. pomatia.*

III.—Trignatha. Mandibles three. Limnæa (excluding Amphipeplea), Ancylus, *Planorbis corneus.*

IV.—Dignatha. Mandibles two, lateral. Cyclostoma, Acme; Paludina, and the other fresh-water Gasteropods.

Dr. Gray, who devotes, in his "Turton's British Shells," page 66, to the consideration of the buccal plates of snails, writes, that "these characters appear to be permanent, as far as they have been observed in the more restricted genera;" but he gives three European exceptions, and states that others occur. One of these is British, *Bulimus acutus*, which "possesses the jaw of a *Helix.*" But the genus *Bulimus* comprises more than a thousand species, divided into numerous sub-genera, and presents types of mandibles parallel to those of the sections of *Helix.* Unfortunately the limitations of the genera are not well fixed; but if the characters afforded by the mandibles, and lingual dentition, be employed for this purpose, due regard being paid to higher structural differences, fewer exceptions to the restriction of types of jaws to certain genera and sub-genera will be found to obtain.

Explanations to Plate.

Fig. 1. Contracted mouth of *Arion ater*, England.
2. „ *Limax Sowerbyi*, England.
3. Mandible of *Limax agrestris*, England.
4. „ *Arion ater*, England.
5. „ *Orthalicus undatus*, Nicaragua.
6. „ *Limax Sowerbyi*, England.
7. „ „ *meridionalis*, Nicaragua.
8. „ *Helix aspersa* (adult), England.
9. „ „ (juv.), England.

10.*a* Mandible of *Cyclotus Dysoni*, Nicaragua.
10.*b* „ „ portion of, showing ornamentation.
11. „ *Pomus urceus*, *a*, back view; *b*, side view, Venezuela.
12. „ *Helix rufescens*, England.
13. „ „ *aspersa* (monstrosity), England.
14. „ *Veronicella Floridana*, Nicaragua.
15. „ *Succinea putris*, England.
16. Mandibular organs of *Limnæa peregra*, England.
a, upper piece; *b b*, lateral pieces; *c*, closed mouth.
17. Mandible of *Helix nemoralis*, England.
18. „ *Bulimus oblongus*, Venezuela.
19. „ *Helix pomatia*, England.
20. Mandibles of *Planorbis corneus*, England.
21. Mandible of *Helicella cellaria*, England.
22. „ *Ancylus fluviatilis*, France.
(after Moquin-Tandon.)
23. Mandibular organs of *Limnæa palustris*, England.

N.B. All the figures, excepting 22, drawn from nature.

HORSE-SHOES, THEIR HISTORY AND ANTIQUITY.

BY LLEWELLYNN JEWITT, F.S.A., ETC.

Every branch of inquiry into the arts of our early forefathers must, if properly and carefully carried out, be attended with important results. No matter whether the inquiry be directed to textile or fictile art, to workings in stone, or metal, or clay, to the art of the

builder, or of the worker in wood, or in leather, or other material, good must result from it; and no matter how small, or how trivial the facts which are brought forward may appear, they all inevitably tend to the expansion of knowledge. It is an incontrovertible truism that the more we understand small things, the more able are we to grasp large ones, and the more we study detail, the more capable shall we be of taking in and comprehending an entire subject. As the world, and everything in it is made up of atoms, so history, whether of a country or a people, of a particular locality or of a special tribe, of an art or of a science, is composed of an infinity of small facts which, like the tesseræ of a pavement, are nothing in themselves, but when judiciously put together, form a complete and beautiful whole.

The subject of horse-shoes is one which commands attention, and it is a subject which, fitting into its place in the history of mankind, helps materially to complete the whole design, and to illustrate his habits and his arts at different periods. In this brief article, therefore, I propose giving a few notes on the history of these useful articles, and, so far as our own country is concerned, to trace their forms and their heraldic and other connections from the earliest period downwards.

That the art of shoeing horses is one of very great antiquity, there is abundance of evidence, not only in the early writers, but, better still, in the examples which have from time to time been brought to light. To the Greeks and Egyptians, despite what has occasionally been advanced to the contrary, it does not appear that horse-shoes were known; neither does it appear that the art of shoeing was practised by the early Romans, although foot-coverings of some kind, probably in cases of disease, were evidently occasionally used—as thus Catullus—

> "Nunc eum volo de tuo ponte mittere pronum,
> Si pote stolidum repente excitare veternum,
> Et supinum animum in gravi derelinquere cœno,
> Ferream ut soleam tenaci in voragine mula."

These were probably but a kind of sock, or sandal, fastened round the legs with straps, or other appliances, and shod with iron or other metal for extra strength and wear—not metal rims attached by nails or clamps to the hoof itself—and it would, therefore, be easily dislodged "in a tenacious bog." Probably the first foot-coverings of horses, adopted in cases of injury to the hoof, or as a preventive of injury on heavy and stony roads, were simply pieces of hide, stitched or laced on with leather thongs, cloth, wicker-work, or

other similar casings, and put on or off in the same manner as those for sore-footed camels, etc. From these socks, or bags, in some instances, doubtless, faced or strengthened with metal, the use of metal rims attached by clamps, and afterwards by nails, would be an easy and natural transition, and it is to these, in so far as regards those of our own country, that I wish to direct attention.

Among the ancient Britons horse-shoes do not appear to have been known, and although their origin is, by Mr. Fleming (who has devoted undivided attention to the subject, and to whose labours I shall call attention later on) ascribed to the Celts, or Gallo-Celts, not a single fragment has ever, so far as I am aware, been found with Celtic remains in Britain. In the early barrows—for it is to the grave-mounds alone that we must turn for our information as to the remains of the ancient Briton—whether along with remains of stone or of bronze implements, no shoe, or fragment of a shoe, has ever, so far as my knowledge goes, been exhumed—and, indeed, it is not at all to be expected that they would. In the earlier barrows, flints, implements of stone, and pottery are found; in the later, in addition to pottery, and occasionally flints, bronze daggers, etc., are met with, but in no case has anything bearing a resemblance to horse-shoes been brought to light. It is pretty evident, therefore, that they were not in use among the ancient Britons. The earliest examples found in this country are of the Romano-British period, and of these, being found with other undoubted Roman remains, there can be no question of age.

Examples of this period have been brought to light at Silbury;

at Headington, where I myself found halves and portions of horse-shoes, along with Roman pottery and other remains, nearly six feet below the surface; at Beckhampton; at Springhead; at York, where some excellent ones, now preserved in the Museum, were found eight feet below the surface, near the bridge which crosses

the fosse; in London, from which place the examples here engraved are taken—the first being found in Lothbury, sixteen feet below the surface, the second in Fenchurch Street, and the third in Moorfields; at Gloucester; at Chedworth; at Cirencester; at Blandford; at Wroxeter, and at many other places. Their general form will be best understood by reference to the engravings already given, and by the remarkably fine example here shown, which was found, along with others, and with other Roman remains, at the depth of nearly ten feet below the surface, in Northgate Street, Gloucester. It "is so little affected," says Mr. Fleming, "by its long sojourn under ground, that but for the fact of its having been found with fibulæ, a lamp, and other characteristic memorials of the Roman era, together with its peculiar form, one would be perfectly justified in asserting it had quite recently come from the anvil of the blacksmith." It weighs $4\frac{1}{4}$ oz., and is $4\frac{1}{4}$ inches long, by $3\frac{7}{8}$ inches wide.

The calkins are rolled over in the usual way, the immense oval depressions for the nail heads being stamped nearly through the metal, and made by a blunt tool when the iron was very hot.

During the time of the Anglo-Saxons, the art of shoeing horses

was continued in this country, and examples are not wanting, both in the illuminated MSS., and among remains which have from time to time been exhumed, to show the form of the shoe, and the

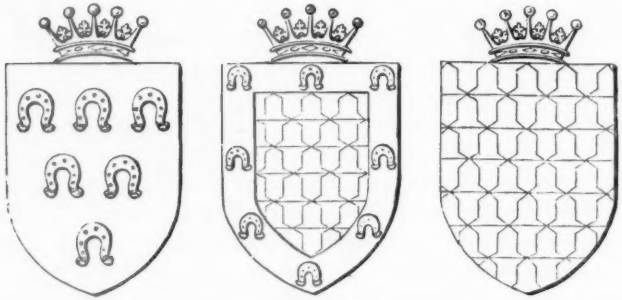
manner of their attachment to the hoof. The form will be best seen in the two engravings here given, from the Saxon graves of Berkshire, and show the outer edge tolerably even throughout, and not "bulged" in the manner in vogue in the previous period.

With the Normans the art was considered so important, that the principal farriers and others to the Conqueror, were richly endowed with lands and possessions in this country. Thus to Simon St. Liz, one of his nobles who accompanied him to England, he gave the town of Northampton, and other lands, on condition of his providing shoes for his horses; to the Saxon chief Gamelhere, at Welbeck, he granted the continuation of his holding of two carucates of land in Cuckney, on condition "that he shod the king's palfreys upon all the feet, with the king's shoes and nails, whenever he visited the manor of Mansfield; if he put in all the nails the king to give him a palfrey worth four marks, but if he lamed the horse, pricked him or shod him straight in shoeing, then he was to give the king one of like value;" to De Ferrers, or Ferraris,* who is said to have taken his name from his office, as the chief of the shoers or farriers to the king, he gave large grants of land in Derbyshire, Staffordshire, and other counties; and to others, grants, both then and later, were likewise made, including one to Henry de Avering, who held the manor of Morton by the sergentry of finding a man with a horse, value ten shillings, and four horse-shoes, one sack of barley, and one iron buckle, as often as the king should go with his army into Wales, at his own proper expense, for forty days.

Henry De Ferrars was one of the commissioners appointed for taking the Domesday survey, and he held, among other lands, the castles and honours of Duffield and Tutbury, at the latter of which places he founded the church "for the soul of King William and Queen Matilda, and for the health of his father and mother, and his wife Berta, and his sons Eugenulph (to whom he gave Duffield Castle), William, and Robert, and his daughters, and his ancestors and friends." His son Robert was the first Earl Ferrars (Comes de Ferrariis), and he in turn was succeeded by his son Robert who, during his father's lifetime, styled himself "Robertus Junior," "Comes de Nottinghame." He succeeded his father as Earl of Ferrars, and either he or his father, for it is uncertain which, was created Earl of Derby. His son and successor, William, married Margaret Peveril, and through her inherited other estates, to one of which, Higham, he added his name—Higham Ferrars. He is said

* It is also supposed that the name was derived from the town of Ferriers, in Normandy.

to have died at the siege of Acre, in 1190, and was succeeded by his son William (2nd), who married a daughter of the Earl of Chester, and was girded with the sword as Earl of Derby by King John. He was succeeded by his son William (3rd), who married a daughter of William Marshall, Earl of Pembroke, and was, in his turn, succeeded by his son Robert, who, for his rebellion, lost his lands which were confiscated and given to the Earl of Lancaster.



The arms of Ferrars were, first, six horse-shoes; second, vaire within a border of horse-shoes; and, lastly, vaire, only; and in connection with these arms, or rather with the horse-shoe as a badge of the Ferrars family, an interesting discovery was a few years ago made by myself. It is a pitcher, dug up in Duffield frith, on the spot where it was made and on the land of De Ferrars, and within a couple of miles of his castle, bearing the badge of the horse-shoe five times repeated, and the buckle (the circular one of the Norman period) twice repeated. These are formed of "slip," as it is technically called, modelled and laid on the surface of the pitcher before firing. The shoes are remarkably well formed, as will be seen from the engravings, and have each six nails, three on either side. Another matter connected with the Ferrars family is the curious custom at Oakham of the town claiming from

every peer of Parliament, whether royal or otherwise, who passes through it, a horse-shoe. The Shire Hall, built by Walkelin de Ferrars, contains a large assemblage of these interesting trophies, arranged on its walls and nailed on its doors; and the arms, as shown on the seal of the town, is also a horse-shoe.

In later times the Marshalls — "marescallus"—Earls of Pembroke, whose duty was "every morning, and late at night, to see that the horses are properly groomed . . . . . and also to ascertain that they are well shod," bore, a horse-shoe and nail on their seals, as is shown on that of Walter Marshall, here engraved; a somewhat similar arrangement, but with the addition of a hammer, being borne on the seal of Ralph, farrier to the Bishop of Durham; and on the seal of Gloucester, where two horse-shoes and twelve nails—the proper number being six for each shoe—are exhibited. In connection with this part of the subject should be noted the fact that in 1235 Walter le Brun had a plot of land granted to him, in the Strand, London, whereon to erect a forge, for which he was to render to the Exchequer, yearly, as quit rent, six horse-shoes, with the nails, sixty-two in number, belonging to them, and this custom has continued ever since, and is the origin of "counting the horse-shoes and hob-nails" on the swearing-in of the London Sheriffs at the Court of Exchequer at the present day. The horse-shoe was painted on the wooden foot-quintain of mediæval times, and it occurs in the arms of the Company of Farriers, and on those of the families of Borlase, Cripps or Crippe, Randall, Ferrars, Shoyswell—evidently *Shoeswell*—and others.

One of the most interesting discoveries of horse-shoes of mediæval times was made some years ago at Tutbury, when the remains of the baggage, military chest, etc., of the unfortunate Duke of

Lancaster, which were lost while fording the river Dove to gain the Derbyshire side, on his precipitate flight from Tutbury Castle, were found, after the lapse of so many centuries, in the bed of that river. The find consisted of an immense hoard of money—some 100,000 silver pennies, it is said—and other relics, and among these, firmly imbedded in the gravel, and forming with the coins, and their own ferruginous matter, a perfect and compact conglomerate, were several horse-shoes and portions of shoes, which are now in my own possession. One of these, to show its position in the mass of gravel, we engrave. The coins along with which these shoes were

found, consisted principally of pennies of the reigns of Henry III., and Edward I. and II., of England; Alexander III., and John Baliol, of Scotland; and some contemporaneous foreign examples, and exhibited an immense number of new varieties and new towns of mintage. The principal towns whose mintages were represented in this find were London, Canterbury, York, Berwick-on-Tweed, Bristol, Durham, Bury St. Edmund, Exeter, Kingston-upon-Hull, Lincoln, Newcastle, Chester, Dublin, Cork, Waterford, etc., and many excessively rare types were discovered, including several episcopal coins.

It is hardly necessary in this brief article on horse-shoes to pursue the subject to a later date than we have done. Those who wish for extended information on this very interesting branch of inquiry—a branch in which every man, woman, and child in the kingdom is interested, for who is there that is not indebted to, and benefited by, the horse? have now, thanks to the labours of Mr. George Fleming, of the Royal Engineers, the opportunity of gratifying that wish to the fullest extent. Mr. Fleming's admirable work on "Horse-shoes and

Horse-shoeing"* is, indeed, all that can possibly be desired, either in an historical, an antiquarian, or, what is of far greater importance to the generality of readers, in a *practical* point of view; and it is a book that everyone, no matter what his "state or calling," ought to possess. To him I am indebted for some of the engravings which illustrate this article. The Duke of Newcastle's grand folio, "Methode et Invention Nouvelle de Dresser les Chevaux," published in 1657, and the still finer edition of 1737 should also be studied for various matters connected with the training and management of horses. The subject is one of great interest, and I feel sure that the readers of THE STUDENT will not be displeased at having their attention thus briefly directed to it.

NOTES ON TERRESTRIAL MAGNETISM.

BY RICHARD A. PROCTOR, B.A., F.R.A.S.,

Author of "Saturn and its System," etc.

THE study of terrestrial magnetism is gradually assuming an importance, which half a century ago few would have thought it could ever attain. It is being brought into intimate relationship with laws affecting not our own earth only, but the whole of the solar system. Indeed, interesting as are the bonds of union which Copernicus, and Kepler, and Newton have traced, in the relations of our system, it would seem as though we were approaching the traces of a yet more wonderful law of association. We see the earth's magnetism responding to the solar influences, not merely in those rhythmic motions which belong to the periodic variations, but in sudden thrills affecting the whole framework of our globe. The magnetic storms which are called into action by such solar disturbances as the one of September, 1859 (witnessed by Messrs. Carrington and Hodgson), are, we may feel sure, not peculiar to our own earth. The other planets feel the same influence—not perhaps in exactly the same way, but according to the constitution and physical habitudes which respectively belong to them. So that one can scarcely conceive a subject of study at once more promising and more interesting, than the science on which I now propose to make a few remarks.

* "Horse-shoes and Horse-shoeing; their Origin, History, Uses, and Abuses." By George Fleming, F.R.G.S., etc. London, Chapman and Hall, 1869.

To deal fully with terrestrial magnetism, would require very much more space than is now at my disposal. The mere history of the science would need a volume; its relations to experimental physics would need another; and one other at least would be required to treat of the theories which are suggested by the interesting relations which have been discovered by modern observers.

In this paper, then, I merely seek to make a few notes on certain points which have occurred to me in reading what Arago, Hansteen, Humboldt, Sabine, and others have said on the subject of terrestrial magnetism. There are certain peculiarities in the way in which the results of observation have been dealt with, which I wish in particular to comment on. I think too, that certain general results appear to follow from what has been discovered respecting the secular variations of the earth's magnetism, which have not yet (so far as I know) been very closely attended to.

There are three features of the earth's magnetic action, which are chiefly attended to by observers,—the *declination*, the *inclination*, and the *intensity*.

The declination is the angle at which the horizontal needle is inclined to the north-and-south line. The inclination is the angle at which the dipping needle is inclined to the horizon. The intensity is the magnitude of the force with which the needle seeks the position of rest.

Now if we travelled over the whole surface of our earth, and carefully determined the declination, the inclination, and the intensity of the magnetic action at every point, we should be able to map down on a chart of the earth, the relations thus presented to our notice. And speaking generally we should have the following peculiarities to deal with:—

First, as to the declination. We should find that in certain regions the magnet's northern end was to the west of north, while in certain other regions the reverse was the case. If we marked in the boundary-line between these regions, it is obvious that we should have traced in a line along which the needle would lie due north and south. This is what is termed a line of no declination. On charts of the earth's magnetic relations, the position of this line for about the middle of the present century, is usually indicated. In some maps a set of lines used to be added, along each of which the magnetic needle had a definite declination. No such lines are now marked in, however. The reason why they are omitted is that they are very complex. But I wish to call particular attention to the omission, for this reason, that the same consideration

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which renders the lines of equal declination unnecessary in a chart of the earth's magnetism, the same reason which gives them a complexity altogether unmeaning so far as the cosmical relations of terrestrial magnetism are concerned, renders also the line of no declination worthy of much less consideration than it has received at the hands of many eminent physicists. I shall presently show why this is so.

Secondly, as to the inclination. We should find as we travelled over the earth's surface, that the dipping needle tends to verticality at two nearly opposite points, one close to the Arctic and the other to the Antarctic circle. These are called the northern and southern inclination-poles, and must not be confounded with the intensity-poles presently to be mentioned. As we leave either inclination-pole the dipping needle leaves its vertical position, and gradually approaches the horizontal direction, until, along a curve lying midway between the two poles, the needle becomes exactly horizontal. This curve is called the magnetic inclination-equator. The present positions of the inclination-poles are indicated in magnetic maps. The inclination-equator is also indicated. The curves which run like parallels around the two poles in such maps, indicate the curves along which the dipping needle has a definite inclination (different, of course, for each curve). Another series of lines, which intersect in the poles, or at least tend towards the poles, run so as to cross the inclination-parallels at right angles. But they illustrate properly speaking the peculiarities of declination. They show in what direction the horizontal needle points in different parts of the earth. But it is to be noticed that as they cross the real meridians at constantly varying angles they are in no way associated with the lines of equal declination described in the preceding paragraph.

Lastly, as to the intensity. If we noticed, in every part of the earth's surface, the number of times the needle vibrated through its position of rest in a given interval (this number affording a very exact measure of the intensity of the magnetic directive action), we should find that along a curve lying near to, but not absolutely coincident with the inclination-equator, the intensity has a minimum value. This curve is called the intensity-equator. Leaving it either towards the north or south, we should find the intensity gradually increasing. We should not, however, find this increase guiding us to a northern or southern intensity-pole; but we should recognize two magnetic intensity-poles in each hemisphere. The positions of these are indicated in magnetic maps. The intensity-equator shows

a certain resemblance to the inclination-equator, but the two equators do not coincide.

Now in considering the various relations here presented, it is very important that we should decide which property of the magnetic needle should receive our chief attention.

General Sabine considers that the intensity is the primary quality of the magnet in all such inquiries as we are at present concerned with; that is, in all inquiries respecting the wider relations of terrestrial magnetism. He remarks that "all that relates to the *force* has a more immediate bearing than what relates to the *direction* of the needle, either in the horizontal or vertical plane; these planes, although necessarily used by us both in observation and discussion, not bearing in themselves any direct relation to magnetism."

Without denying the force of these remarks, I could yet venture to point out reasons why the force is a less suitable relation than the direction, where the question is one of mapping down the equator, parallels, and poles, which are to teach as something of the earth's magnetic action and its secular changes.

I must premise that the declination and the inclination may be combined in a single indication—viz., the *direction*, with a certain convenience so far as the general teachings of terrestrial magnetism are concerned; but that if we are to select one or other of these elements of the direction as our special guide, it must clearly be the inclination. For a glance at a map of the earth's magnetic relations will show that over all the earth, except those regions which lie close to the poles, the declination has comparatively narrow limits of range, whereas the inclination varies from 0° to 90°.

Now the great point to be determined by the student of terrestrial magnetism is the situation of the true magnetic equator and poles. The existence of more poles than one in each hemisphere is clearly a peculiarity depending on the irregular conformation of the earth's frame, combined—in some way as yet unknown—with the external influences on which the primary facts of terrestrial magnetism depend. We cannot doubt that if the earth were a homogeneous sphere she would have a definite magnetic axis and a definite magnetic equator, which would be the same in position, whether we considered them with reference to the intensity or the directive power of the needle. And what we must do if we are to learn what position the magnetic axis and equator would have, *but* for terrestrial irregularities, is to select that relation for our guidance which is least likely to be affected by such irregularities.

Now I shall be able, I think, to show that the inclination has a

very great advantage over the intensity in this respect. The matter is very simple, and has as yet, as it seems to me, been very little considered.

How do we determine the intensity-equator and the intensity-poles? The answer is, by determining where the intensity is a maximum or a minimum. Now, it is a well-known principle that variable quantities change slowly in the neighbourhood either of a maximum or of a minimum; so that if we have to determine the position either of a point where the intensity has a maximum or minimum value, we might easily make a very appreciable mistake, merely from the fact that there is so slow a rate of change near such a point, and that small irregularities due to local peculiarities may easily set us far astray.

The fact, then, that the intensity-poles and the intensity-equator are found by the determination of a maximum or minimum is very unfavourable to the choice of this relation, intensity, as our guiding element. It is as though an astronomer were required to determine the seasons of the year, not by observing the sun's passage of the vernal or autumnal equinox (which is comparatively easy because the sun crosses the equator at a considerable angle), but by noticing when the sun attained his greatest distance above or below the equator, which is not easy because his distance from the equator changes so very slowly at those times, when, in fact, his motion is all but parallel to the equator.

Let us see if there is any difference when we consider the inclination.

The inclination-poles and equator are determined by noticing where the dip is 90° and 0° respectively. Now the dip changes *through* these values as sharply as it changes through any other values. In other words, a change of place on either side of the line of no dip, or on either side of the place of the vertical needle, produces quite as much change in the inclination as a similar change of place from any of the inclination-parallels. The fact is, that if we could travel from one of the inclination-poles to the inclination equator, thence to the other pole, and so on until a complete circle of the earth had been made, we should find the dip changing from 90° down to 0°, thence to 90°, and so through 0° to 90° again, and always at the same rate, precisely as the elevation of the pole of the heavens would change if we could make the circuit of a meridian.

It seems to me that for these reasons the inclination of the magnetic needle is an element whose indications are far less likely

to mislead us than those of the intensity. In fact, it appears almost as unreasonable to be guided by the intensity in determining the true magnetic equator, as to endeavour to determine the position of the earth's equator by a reference to the distance of different points on the earth's surface from the centre of our globe. Doubtless, a curve approaching the earth's equator *pretty nearly* might, with much labour, be determined in this way; but the determination by a reference to the elevation of the celestial pole is not likely to be abandoned by astronomers on that account.

Now, having determined that the directive power of the needle is the guide which can best lead us to the determination of the true magnetic equator and poles, we must yet make some remarks on the two elements of the magnet's direction.

A stress which appears to me altogether unreasonable has been laid on the position and motions of the line of no declination. In every work on terrestrial magnetism with which I am acquainted, this line is made the subject of a long disquisition. Humboldt, Arago, Hansteen, and Sabine discuss its present peculiarities, and the peculiarities of those motions by which it has reached its present position. In fact, in endeavouring to form a general idea of the laws which govern terrestrial magnetism, these and other eminent physicists have paid more attention to the motions and peculiarities of this line than to any other feature.

I would ask whether the line of no declination really merits such close attention; whether rather it is not, of all the curves associated with magnetic mapping, the one most likely to lead us astray. And to prepare the reader to pay closer attention to this point, than, in the face of so many eminent authorities he might care to do, I may just mention the fact that (whether the line of no declination is *calculated* or not to lead us astray) it actually has led physicists to form directly opposite conclusions on a matter of extreme simplicity. The most striking feature of the line is its rapid change of position, and yet physicists cannot agree which way it is travelling. Arago says it is clearly travelling from east to west. On this Sabine remarks that quite obviously the line is travelling from west to east, and he quotes Hansteen's maps in confirmation; but Humboldt, who had carefully studied Hansteen's maps, takes the same view as Arago.

The real fact is, that the choice of "the line of no declination" as a guide to the real history of magnetic changes, is as unfortunate as the choice of the intensity as a guide to the position of the true magnetic equator and poles; and for much the same reason. The

slightest irregularities due to the effects of the configuration of different parts of the earth's surface, suffice to cause the line of no declination to assume the most complex and irregular figures. And again, the grand process of cosmical action which leads to a continual change in the position of the magnetic equator, causes the true line of no declination (that is, the line along which, if the earth were a perfectly uniform globe, there would be no declination) to be continually subjected to new irregularities, which have no bearing whatever on the cosmical laws of terrestrial magnetism.

Let me illustrate my meaning by two examples:—

What is required, that a point should be on "the line of no declination," is that the magnetic direction-lines should there be running north and south. Now suppose that on a certain portion of the earth the direction-lines have the position of the waved lines only running north and south near their middle points. Then a curve through these points belongs to the line of no declination. But now conceive that, through some irregularities of the earth's substance in this neighbourhood, the lines are slightly twisted, so that at these points they do not run north and south but nearer the general direction of the waved lines; and we have every reason to believe that differences of configuration of the earth's crust produce far greater effects on the direction-lines. Then there are no points at all belonging to the line of no declination, within the area covered by the lines. Thus the portion which had crossed this area disappears altogether, merely through the effects of a small irregularity in the earth's action.

Next consider a case where a set of direction-lines have no points of inflection, but become north-and-south without change of curvature. Suppose that here, also, a slight change is produced on the position of the direction-lines by local irregularities, and that this change produces (as it commonly would) a change of curvature where the convexity of the lines had touched the north and south lines. Then, in place of a single line, we should have three lines of no declination across this region of the earth.

What reliance, then, can be placed on the indications of a curve which is liable to such remarkable changes of figure, through disturbances quite within the limits ascribable to the effects of local irregularities in the magnetic action? For it is to be remembered, that the cases I have cited are not instances carefully selected to exhibit, in a magnified form, the effects of local irregularity. The direction-lines can only assume a north-and-south position in one of the two ways considered; that is, either by inflecting or by

presenting their convexity to the terrestrial meridians. Nor are such disturbances, as I have considered, by any means exceptional. On the contrary, everything tends to show that at every point of the earth's surface the main effects due to the earth's magnetic action are slightly modified by local irregularities. If a plan had been wanted for losing sight of the main effects of magnetic action, no better one could have been thought of than that of selecting the "line of no declination" as a guide. One might as well attach importance to a line on the earth, showing where gravity acts in an exactly vertical direction. We know that, owing to local irregularities, we should find such a line to be looped and twisted into curves of the strangest complexity, but no one has ever thought that those curves could teach us any great truths respecting gravity.

The reader will gather from the above remarks, that my chief aim in these notes is to draw attention to the more marked characteristics of terrestrial magnetism. Any chart of the earth's magnetic relations will serve to illustrate what remains to be said; but stereographic charts * of the northern and southern hemispheres are the best. The irregularly curved line with its companion loop, which forms the "line of no declination," may be left out of consideration. Nor need we pay much attention either to the magnetic intensity poles. The inclination-equator, the series of lines and parallels belonging to the same element of the magnetic action, and the poles towards which these lines tend, or around which they lie, are to be our principal guide.

The magnetic poles are not directly opposite each other. A point directly opposite the estimated place of the southern magnetic-pole (Ross was unable to reach this point) would lie to the west of the northern magnetic-pole, and nearer the true pole of the earth. And it is worth noticing that many of the direction-lines

* My reason for mentioning this projection in the present instance is that it presents correctly all the angles at which the various lines on the earth's surface intersect each other. This is important in the case of magnetic charts. Otherwise I have no great liking for the stereographic projection. In my "Handbook of the Stars," I have pointed out the incorrectness of the view expressed by Professor Hughes, Nichol, and Airy. that this projection is suited for exhibiting the earth in hemispheres, remarking that however truly the projection exhibits small figures, it cannot (as alleged) exhibit continents without great distortion. A look at Asia and at South America as exhibited in such stereographic charts as I have suggested, will serve to show that this view is just. It is important, however, to notice one great advantage of the projection, for the purpose mentioned. All circles on the sphere are projected into circles, so that where we see the magnetic parallel somewhat oval in figure, we know that they really do depart from the circular form.

around the northern pole, seem to indicate a point further west, as that to which they really tend. All those which cross the northern parts of the Pacific, exhibit such a tendency in a very marked manner. This is a circumstance of which I shall presently have occasion to remind the reader.

The magnetic-equator exhibits a tolerably uniform sweep, but it is not a perfect circle. It will be noticed that where it crosses the ocean, it seems to seek a more northern course.

Next as to the parallels. It seems worth noticing that as a general rule the neighbourhood of the great continents seems to sway these curves away from the nearest magnetic pole. The parallels in fact assume in the northern hemisphere an oval figure, the direction of the major axis lying along a meridian through Asia and America. The way in which the parellel nearest the southern pole is swayed northwards where it crosses Australia, is also well worth noticing.

These irregularities are neither marked enough in their character, however, nor consistent enough in their indications to detain us here. Nor need anything be said about the peculiarities of the magnetic direction-lines (or meridians, as they have been somewhat strangely named).

Now let us remember what these lines and parallels represent. When we see London and New York nearly on the same magnetic parallel, we learn that the inclination of the dipping needle is nearly the same in London as in New York. If we go south from either place the inclination diminishes, if we go north it increases.

Suppose, then, we find that as time passes the inclination in London or in New York is changing, what opinion are we to form? We can arrive at no other conclusion than that the distance of these places from the magnetic pole is changing. And since London and New York are not changing their place on the globe, we conclude that the magnetic pole is in motion.

But the inclination in London *is* changing, is in fact steadily diminishing. We can at once interpret this change. Since by travelling away from the magnetic pole, we discover a continually diminishing inclination, England must be receding from the nearest magnetic pole; in other words the northern magnetic pole is receding from England. We see at once that the magnetic pole must be travelling westward.

But now let us adopt a new mode of discussing this important secular variation.

One of the most thoroughly established of all the peculiarities of

terrestrial magnetism is the fact that the magnetic declination varies from time to time. In London and Paris the variations of the declination have been observed more carefully, and for a longer time, than at any other place. Let us inquire what we can learn from them.

They may be briefly stated thus :—

In London the needle pointed to the east of north before the year 1657 when it pointed due north. From that time the westerly declination gradually increased, until the beginning of the present century, when the westerly motion was observed to flag. In 1819, the greatest westerly declination was reached. At this time the needle pointed $24\frac{3}{4}$ degrees to the west of north. Since then the needle has been slowly travelling eastwards, and the westerly declination is now only 21 degrees.

In Paris the needle pointed due north in 1663. Its subsequent motions have closely resembled those of the London needle; but the Paris needle ceased to move westwards as early as 1817, and the greatest westerly declination attained by it was only $22\frac{1}{2}$ degrees.

Now we can easily interpret both these sets of movements. If we were to perplex ourselves by looking at the line of no declination, to see where the needle points due north, we might indeed go very far wrong. But if we seek for direction-lines, which have a *general* north and south direction, we see that these lines lie nearly on the great circle passing through the northern magnetic pole and the pole of the earth. It follows, that at some time near the year 1657 the northern magnetic pole must have been on the meridian of Greenwich, or on the prolongation of this meridian forming the meridian 180 E. (or W.) of Greenwich. In other words the magnetic pole must either have been directly between England and the real pole of the earth, or directly beyond the pole.

To determine which of these positions the magnetic pole had is very easy. If this pole were between England and the real pole of the earth, it is obvious that the magnetic inclination in England would have had a maximum value. In the other case, the inclination would have had a minimum value. But the inclination has been continually diminishing since 1657. Hence it then had a maximum value; and the northern magnetic pole lay between England and the real pole of the earth.

Also we can tell which way the magnetic pole was travelling. For before 1657 the declination was easterly, whereas afterwards it was westerly. Hence the magnetic pole must have travelled from

east to west round the north pole of the earth. This agrees with our former result.

We can learn also something about the rate at which the magnetic pole is travelling.

Supposing the magnetic needle in the meridian of London in 1657, and Ross's estimate of the place of the magnetic pole to be appreciably correct, giving (in round figures) 95° W. of Greenwich for the longitude of the magnetic pole in 1833, we get a period of revolution of

$$\frac{360}{95} \times (1833-1657) \text{ years}$$
$$= \frac{72}{19} \times 176 \text{ years} = 667 \text{ years about.}$$

Combining Ross's estimate with the Paris epoch, we get a period of

$$\frac{72}{19} \times (1833-1663) \text{ years.}$$
$$= \frac{72}{19} (\times 170) \text{ years} = 644 \text{ years about.}$$

The mean of these values is about 655 years, and I think there is very good reason for believing that the northern magnetic pole revolves around the north pole of the earth, from east to west, in about this time.

The southern magnetic pole must, of course, have the same period of rotation as the northern. Hence a portion of the discrepancy alluded to above, between the northern magnetic pole and the antipodes of the southern, as estimated by Ross, is accounted for. Because Captain Ross determined the position of the northern pole ten years before he endeavoured to reach the southern one; and in ten years the northern pole had rotated over a considerable arc towards the west.

The magnetic equator must also vary in position. Its inclination to the real equator may perhaps be nearly constant, but its nodes must travel round from east to west, making a complete revolution in the same period as the poles. Such a motion has been actually observed.

I am sensible that when we examine the changes of the declination and inclination, over the whole face of the earth, so far as they have hitherto been determined, we shall find many irregularities which seem, at first sight, not easily reconciled with the above views. But it will be found that it is only when weight is placed on the relatively unsatisfactory indications already mentioned that these peculiarities become perplexing. Three circumstances which have been much dwelt upon as opposed to the existence of such a rotation of the magnetic poles as I have described, remain to be mentioned as among the clearest evidences that that rotation

is actually taking place. Over the Chinese empire, Humboldt says, the change in the magnetic declination has been very slow indeed for several centuries. In Jamaica, Sir J. Herschel notices the needle has pointed nearly due north for many years; and lastly Arago notices a similar peculiarity in the case of South Australia. Now if we look at a chart of the earth's magnetic relations, we shall see that the reason of these peculiarities is closely bound up with the rotation I have described. The northern magnetic pole in passing from the meridian of Greenwich to its present position, has passed the point where it has its greatest distance from the Chinese empire, and consequently the oscillation of the needle (by the reverse of what was inferred for the case of London) would be slowest during the centuries occupied by this passage. In Jamaica and Australia the neighbouring magnetic pole lies nearly due north and due south respectively, and has lately passed the meridian of those places, so that here, as in England in the middle of the seventeenth century, the needle has for many years had a small declination.

CLASSICAL ALLUSIONS TO CICADÆ.

BY REV. W. HOUGHTON, M.A., F.L.S.

THE group of hemipterous insects known to entomologists as the Cicadidæ is one of particular interest, both in a historical and zoological point of view. Who has not heard of the *tettix* (τέττιξ) of the ancient Greek, and the *cicada* of the Roman writers? How many modern travellers have spoken of the stridulating sound produced by the male insect, which so much delighted the ears of Homer and Anacreon? To the naturalist who, with the aid of dissecting scissors and lens, examines the wonderful mechanism of insect organization, the structure of the sound-producing organ of the cicada must afford ample material for curious investigation.

The cicada was known to the ancient Egyptians, and was figured on their sculptures. Horapollo ("Hieroglyph." ii. 55) says that, "when they wished to symbolize a mystic man, and one initiated in the sacred rites, they used to depict a cicada, for he does not utter sounds through his mouth, but sings a sweet melody by means of his spine" (διὰ τῆς ῥάχεως). Some of the Greeks appear

to have entertained the same erroneous notion as to the position of the sound-producing organ, which they supposed was placed somewhere in the back. Ælian seems to have been of the same opinion when he says, "all singing birds have well-formed mouths, and speak with their tongues, like men, but the cicadæ speak through their loins" (*κατά τὴν ἰξύν*); unless the Greek word more properly means "thigh," as it must do in the following passage of Archias ("Anthologia," iii. 24, ep. 7)—

Ἔκρεκες ἐντάρσοιο δι' ἰξύος ἀχέτα μολπάν
Τέττιξ.

O shrill cicada, you make music by means of your delicate-footed thigh.

So it is not improbable that the ancient Greeks thought that the cicada produced its sounds by the attrition of the thigh against the wing-cover, as in our common grasshoppers. The ancients were well aware of the fact that the male insect alone is capable of producing the characteristic sounds which were so much appreciated by them. There was, however, difference of opinion amongst them on this point. Homer speaks of "good orators, like the cicadæ, which, sitting on a tree in the woods, send forth their delicate voice." ("Iliad," iii. 191). Virgil does not copy Homer in this idea at least, when he says—

Et cantu querulæ rumpent carbusta cicadæ.
Geor., iii. 328.

In another passage he applies the epithet "hoarse" to these insects. Hesiod admired their chirpings—

When the green artichoke ascending flowers;
When in the sultry season's toilsome hours,
Perch'd on a branch beneath his veiling wings,
With shrill sweet note Cicada frequent sings.
"Works and Days," 582.

The habit of the cicada's singing at the hottest part of the day is often mentioned by ancient writers. Hesiod has the following lines—

'Twas in that season when, on some green bough
High-perch'd, the dusky-wing'd cicada first
Shrill chants to man a summer note; his drink,
His balmy food, the vegetative dew.
The livelong day from early dawn he pours
His voice; what time the sun's exhaustive heat
Fierce dries the frame——
"Shield of Hercules," 393.

But Tennyson represents both the grasshopper and cigala as silent in the heat of the day—

> For now the noon-day quiet holds the hill,
> The grasshopper is silent in the grass;
> The lizard, with his shadow on the stone,
> Rests like a shadow, and the cigala sleeps.
> "Œnone."

Anacreon has devoted an entire ode to the cicada, which is thus translated by the poet Moore—

> Oh thou, of all creation blest,
> Sweet insect, that delight'st to rest
> Upon the wild woods' leafy tops,
> To drink the dew that morning drops,
> And chirp thy song with such a glee,
> That happiest kings may envy thee.
> Whatever decks the velvet field,
> Whate'er the circling seasons yield,
> Whatever buds, whatever blows,
> For thee it buds, for thee it grows;
> Nor yet art thou the peasant's fear,
> To him thy friendly notes are dear;
> For thou art mild as matin dew;
> And still, when summer's flowery hue
> Begins to paint the bloomy plain,
> We hear thy sweet prophetic strain;
> Thy sweet prophetic strain we hear,
> And bless the notes, and thee revere!
> The muses love thy shrilly tone,
> Apollo calls thee all his own;
> 'Twas he who gave that voice to thee,
> 'Tis he who tunes thy minstrelsy.
>
> Unworn by age's dim decline,
> The fadeless blooms of youth are thine,
> Melodious insect, child of earth,
> In wisdom mirthful, wise in mirth;
> Exempt from every weak decay,
> That withers vulgar frames away;
> With not a drop of blood to stain
> The current of thy purer vein;
> So blest an age is pass'd by thee,
> Thou seem'st—a little deity!

The happiness of the cicada is attributed by a comic poet, Xenarchus of Rhodes—ungallant man!—to the fact, that the female insect was incapable of producing sounds, the gentlemen having all the talk to themselves—

> Happy the cicadas' lives,
> Since they all have voiceless wives!

Plutarch, in a chapter of the "Symposiacs," which treats of certain Pythagorean precepts—one of which forbade the admission of swallows into the house—tells us one of the reasons was because these birds ate cicadas—

> Consider and see whether the swallow be not odious and infamous . . . . for she feedeth upon flesh, and besides, killeth and devoureth cicadas, which are sacred and musical.—"Sympos.," viii., Holl. Trans., p. 777.

Timon, as quoted by Diogenes Laertius ("De vitis Philosophorum"), speaks thus with reference to Plato—

> A man did lead them on, a strong stout man,
> A honeyed speaker, sweet as melody
> Of tuneful tettix, who, seated high
> On Hecademus tree, unwearied sings.

It would seem, from a passage in Strabo, that the Greek geographer had some faint notion of the mode by which the Cicadidæ produce their stridulations. He says there is a curious fact respecting the *tettiges* worth mentioning—that those which are on the Locrian side of the river Alece sing, but those on the Rhegium side are silent; and it is thought probable that this is caused by the region being woody, and the insect's *membranes* being softened by damp, so that they cannot produce any sound; while those on the Locrian side, being sunned, have their membranes dry and horny, so that they can readily produce sounds. Strabo tells us a story about two harpers who were contending for the prize at the Pythian games—one was a Locrian, Eunomus by name; the other was a Rhegian, called Aristo. Eunomus thought that Aristo had no right to contend in a musical contest with any one, because that amongst his nation even the *tettiges*, the most musical of all creatures, were mute. However, the contest did take place, and Aristo was well-nigh winning the prize, for his rival harper broke a string of his instrument; but a *tettix* quickly came to the rescue of Eunomus, and sat upon his harp, supplying by its notes so efficiently the loss of the string that he was declared victor. ("Georg." Book vi. 9.)

Ovid refers to the singing of these insects during the summer in the following lines—

> Vere prius volucres taceant, æstate cicadæ,
> Mænalius lepori det sua terga canis.

He is giving advice to young lovers to persevere, for all women may be won. "Sooner would the birds be silent in spring, the cicadæ in summer; sooner would the Mænalian hound turn its back

upon the hare, than the fair maiden, sweetly courted, refuse the youth." Little Greek boys used to keep both grasshoppers and cicadæ in rush cages, and to feed them with a plant called *gethyon*, which appears to be some kind of garlic. Poetry and fact are here strangely at variance. Bad taste, perhaps, in "the prophets of the muses" to be fond of garlic; but as the Greeks themselves were so partial to this herb, it was only natural for them to suppose that their little pets possessed a kindred taste. Theocritus has drawn an admirable picture of a little boy, set to keep the fowls from the vines, so intent upon the construction of one of these insect cages, that he allows one fox to eat away at the grapes, and the other to run away with his dinner. The passage has been translated by Dr. Chapman with his usual spirit and taste.

> And near that old man, with his sea-tanned hue,
> With purple grapes a vineyard shines to view.
> A little boy sits by the thorn-hedge trim,
> To watch the grapes—two foxes watching him;
> One through the ranges of the vines proceeds,
> And on the hanging vintage slily feeds;
> The other plots and vows his scrip to search,
> And for his breakfast leave him—in the lurch.
> Meanwhile he twines and to a rush fits well
> A locust-trap with stalks of asphodel,
> And twines away with such absorbing glee,
> Of scrip or vines he never thinks—not he!
>
> "Id." i.

Cicadas are kept in cages by the modern Spaniards and by the Chinese. "The shops of Hai-tien, in addition to necessaries," we are told, "abounded in toys and trifles calculated to amuse the rich and idle of both sexes, even to cages containing insects, such as the noisy cicada and a large species of the gryllus."

The Athenians were particularly attached to the cicadas, considering them an emblem of their claim to be *ἀυτόχθονες*, "of native stock" sprung, as it were, from the ground, as they supposed was the case with the insects. They were fond of wearing golden representations of cicadæ as ornaments in their hair and on their dresses. Thucydides tells us that this custom ceased not long before his time. Notwithstanding the affection of the Greeks for these insects, they did not object to eat them. Ælian not unnaturally wonders that his own cotemporaries should eat animals sacred to the muses.

The cicadæ are, for the most part, inhabitants of warm climates. We have one British species, the *Cicada Anglica*, discovered about thirty-five years ago in the New Forest by Mr. Bydder. A figure

of this insect may be seen in Curtis's "British Entomology," No. 392. The species known to the ancients was probably the *C. plebeia,* common in the south of Europe. The family is widely distributed, being found in warm countries all over the world. Travellers have expressed surprise that the ancients should have appreciated the shrill monotonous sounds the male cicadæ produce. Certainly there is no accounting for taste. Sir E. Tennent says that one species in Ceylon has received the name of the knife-grinder, from the similarity of its noise to a cutler's wheel. It is stated that a species in Brazil may be heard a mile off.* There is an American cicada which, from its supposed periodic visitations every seventeen years, has received the name of *C. septemdecim,* or more popularly, "the seventeen year *locust.*" About the peculiarity of its periodic migrations there is difference of opinion; some maintain that this is a mistake. However, Dr. Asa Fitch, a high American authority in all matters relating to insects, says that it "is a remarkable fact with respect to this species, that, in different districts of our country, broods appear in different years; yet the brood of each district invariably preserves the interval of seventeen years for coming out in its winged state." This species is included in the number of noxious insects by Dr. Asa Fitch (see Report 1 and 2, p. 38). It wounds the twigs, and causes them to wither and die. Oak-trees appear to be most frequented by them. By means of a sharp ovipositor it pierces the bark of the branches, and lays its eggs in the hole pierced. "From the wounds which are thus made in the limbs the sap exudes often profusely, and extensive injury is often done."

* It is probable that there is a difference in the sounds produced, according to the species, for Mr. J. K. Lord, in speaking of a new and beautiful Cicada he found at the Cascade Mountains ("Intellectual Observer," viii., p. 429), says its song was "more singularly tuneful than any other."

FARADAY AS A MAN.*

DR. BENCE JONES presents us, not so much with a "Life of Faraday," as with an edition of diaries, letters, etc., of the great philosopher, from which we obtain interesting glimpses of his character, and of his peculiar methods of self-culture and study.

The village of Clapham, in Yorkshire, was the spot where Faraday's immediate ancestors were born and bred. They belonged to the small and peculiar sect of the Sandemanians, or Glassites, followers of John Glass, a minister expelled from the Scotch Kirk about 1728, for maintaining that "the Kingdom of God is not of this world," in a manner that struck at the root of all establishments. Sandeman was a successor of Glass, and differed from the Calvinists on the point of justifying faith, to which he gave a simple interpretation. The Sandemanians appear to have been a very earnest, simple-minded people, with strong notions of human brotherhood and church discipline. The Yorkshire Faradays inhabited a quaint little house called Clapham Wood Hall, and James, the father of Michael, by whom the name was immortalized, was a blacksmith, and married to a farmer's daughter. James and his wife came to London, and settled at Newington Butts, where Michael, his third child, was born on September 22, 1791. James moved to Gilbert Street, and then to rooms over a coach-house in Jacob's Well Mews, Charles Street, Manchester Square. He worked as a journeyman at Boyd's, in Welbeck Street, and when the old system of taxation and legislation brought corn to the famine price of £9 a quarter (in 1801), the family was so poor as to need parish relief, and one loaf a week was Michael's share. James had joined the London congregation of Sandemanians, and bore his troubles of poverty and ill-health in a truly religious spirit, leaving all "to Him who has a sovereign right to do what seemeth good to Him, both in the armies of heaven and amongst the inhabitants of the earth."

Faraday's school education was, as might be expected from these details, of a very meagre description. He describes it "as consisting of little more than the mere rudiments of reading, writing, and arithmetic at a common day-school." His hours out of school "were passed at home and in the streets." In 1804, he went as an errand-boy to Mr. Riebau, and had to carry out newspapers, which his master lent, and fetch them back again. On Sunday the

* "The Life and Letters of Faraday." By Dr. Bence Jones, Secretary of the Royal Institution. Two vols. Longmans.

customers were often dilatory and troublesome, and it grieved young Faraday if they would not let him finish his work in time to make himself neat, and go with his parents to the Sandemanian church. To his last days he felt a tenderness for newspaper boys, remembering that he had carried newspapers himself. In 1805 his apprenticeship began, and he worked hard to learn his trade of bookbinder and stationer, devoting his leisure to such scientific books as he could obtain, especially delighting in Mrs. Marcet's "Conversations in Chemistry," and the Electrical Treatises in the "Encyclopædia Britannica." He tells us that he made such experiments as a few pence a week could obtain; and constructed an electrical machine, first with a glass phial, and afterwards with a real cylinder. Fortunately his master allowed him to go of an evening to the lectures of Mr. Tatum in Dorset Street, and his elder brother, Robert, contributed to the cost, which was one shilling per lecture. Here he met Magrath, Newton, Nicol, and others. That he might illustrate the lectures, he studied perspective under Macquerrier, and made notes from books on subjects that interested him.

Through the kindness of Mr. Dance, a customer in his master's shop, he had an opportunity of hearing four lectures by Sir H. Davy at the Royal Institution, and in his zeal to obtain scientific employment, wrote to Sir Joseph Banks, then President of the Royal Society, who took no notice of the letter. A later application to Sir H. Davy met with a better fate.

Many of the earlier letters are addressed to his friend Abbot. They are, perhaps, a little tiresome, but we cannot read them without wondering how the poor boy had managed to learn so much science and command of language as they display. The firmness and excellence of Faraday's moral character was displayed from early years. He was very careful in his selection of associates, and told Abbott he "could not admit that an immoral person can fill completely the character of a true friend."

It was in March, 1813, that Faraday went to the Royal Institution, as laboratory assistant to Davy, at a salary of twenty-five shillings a week, and two rooms at the top of the house. Not contented with what he could learn in assisting Davy's researches, he joined a body called the City Philosophical Society, and a few of its members met once a week in his rooms, to improve each other in composition, pronunciation, etc.

In 1813, Sir H. Davy and his assistant had some narrow escapes from the explosive violence of chloride of nitrogen, just discovered, and both received unpleasant injuries in spite of their precautions.

Throughout his career, Faraday attached great importance to all the details of lecturing—method, voice, gesture, precision, regard for time, etc., etc.; and he had a card to be placed before him at one period to remind him to be slow enough, while Anderson, his well-known assistant, had another in readiness to keep him from exceeding the appointed hour. When twenty-one, he wrote an essay on lecturing in the form of a letter, in which he said, "a lecturer may consider his audience as being polite or vulgar (terms I wish you to understand according to Shuffleton's new dictionary), learned or unlearned (with respect to subject), listeners or gazers. Polite company expect to be entertained not only by the subject of the lecture, but by the manner of the lecturer; they look for respect, for language consonant to their dignity, and ideas on a level with their own. The vulgar—that is, in general, those who will take the trouble of thinking, and the bees of business—wish for something they can comprehend." Royal Institution audiences still exemplify these distinctions. The "polite company" could not get on without incessant fireworks and the electric light; while the "vulgar," who think, are difficult to attract in sufficient numbers to furnish a few dozen listeners to a lecture on any subject the "polite company" would vote dry.

In 1813, Faraday made a continental journey with Sir H. and Lady Davy, and took advantage of the opportunity of becoming acquainted with French and Italian. Lady Davy—the first—appears to have been an exacting, troublesome personage, who made Faraday uncomfortable when they had no valet for her to tease, and the young philosopher had to do some portion of servant's work. Davy himself behaved much better, but a painful snobbishness cropped out when De la Rive invited him and his assistant to dinner, and he found that his "dignity" would be hurt by sitting down with his servant! No glitter of the empire of the First Napoleon could blind Faraday to the character of his system, and though few remarks are made on France, they are very characteristic; for example, the great collections at the Louvre called forth "his highest and most unqualified admiration," for the height to which they proved man to have arisen; but, "when memory brings to mind the manner in which the works came here, and views them only as the gains of violence and rapine, she blushes for the people that even now glory in an act that made them a nation of thieves."

The numerous letters written from the continent form a very interesting part of Dr. Bence Jones' "Life of Faraday." He

assisted Davy during his travels in a variety of interesting investigations, made the best of Lady Davy's annoyances and frequently found pleasure in works of art or natural scenery, but a vein of half sadness runs all through. The degraded condition of continental nations wounded his moral sense, and though no politician he had a keen eye for social evils. Science was the mistress to whom he was ever faithful, but no fresh discoveries or brilliant researches had the least effect in weakening the simple religious earnestness of his nature, and it never seems to have occurred to him to mingle any speculations drawn from science with his religious faith, which he preserved to the end as a separate and sacred department, to which no doubt had access. His want of interest in ordinary secular affairs is curiously shown in a diary entry in 1815. "Tuesday, March 7th, I heard that Bonaparte was again at liberty. Being no politician, I did not trouble myself much about it, though I suppose it will have a strong influence on the affairs of Europe." Soon afterwards we find him delighted at the prospect of coming home, as Sir H. Davy had suddenly made up his mind to return. He writes affectionately to his mother anticipating a meeting, and adds a request that she would tell "some of his dearest friends," but not everybody. He says he is of "no consequence except to a few," and "there are but few of consequence to him."

During a visit to Devonshire, Faraday wrote characteristically to his mother; "I have seen a good deal of country life since I left town, and am highly pleased with it, though I should by no means be contented to live away from town. I have been at sheep-shearing, merry-making, junkettings, and I was never more merry; and I must say of the country people (of Devonshire at least), that they are the most hospitable I could imagine. I have seen all your processes of thrashing, winnowing, cheese and butter making, and I think I could even now give *you* some instruction, but all I have to say to you on these subjects shall be said verbally."

In 1820, Faraday was engaged "to be married to Sarah, the third daughter of Mr. Barnard of Paternoster Row, an elder of the Sandemanian Church," and this, as his biographer says, made him a happy man for forty-seven years. Like many other men untouched by the sacred flame, he had written against love, and his memoranda on this subject were known to Miss Sarah. When his conversion from the bachelor heresy took place, he frankly and simply confessed his mistake, and assured the lady that he "did not claim to bend her affections for his own sake only," but "in whatever way he could best minister to her happiness, either by assiduity or

absence, it should be done." "Miss Barnard showed this letter to her father, and he, instead of helping her to decide, said that 'Love made philosophers into fools.'" Faraday's feelings during a brief period of suspense were in a state of profound agitation, and his joy was calm and intense when the lady said the happy word. By March, arrangements were made for him to take the position of superintendent of the house, as well as of the laboratory, and on the 12th of June he was married in the quietest way. We are told that he offended some of his near relations by not asking them to the wedding, and, in a letter written just before, he said, "There will be no bustle, no noise, no hurry occasioned even in one day's proceedings. In externals that day will pass like all others, for it is in the heart that we expect and look for pleasure." Twenty-eight years after, in the notes of his life, he wrote: "On June 12, 1821, he married—an event which more than any other, contributed to his earthly happiness and healthful state of mind. The union has continued for twenty-eight years, and has never changed, except in the depth and strength of its character." A month after his marriage, he made his confession of sin and profession of faith before the Sandemanian church. "His faith in Christ he considered to be the effect of Divine Power;" and, when his wife asked him why he had not told her what he meant to do, the answer was, "That is between me and my God." In the church of his selection he would listen to the prayers and exhortation of the most illiterate brother. His refusal to apply ordinary methods of investigation to theological matters, resulted from a conviction that there was "an absolute distinction between religious and ordinary belief," and he therefore deliberately refused to "apply those mental operations which he thought good in respect of high things, to the highest." Faraday's theology appears to have been much simpler than that of the orthodox churches, and it is in no spirit of disparagement that we may say he inherited the opinions as well as the religious temperament of his father and mother.

Admirable in every respect as was Faraday's moral character, he did not escape an unjust charge of acting unfairly to Wollaston in a matter of priority, and Sir H. Davy, unhappily, after all had been explained and cleared up, opposed his election as a fellow of the Royal Society. Still, on the whole, he avoided controversy very successfully, and won esteem on all hands.

The simplicity of his tastes is constantly shown in his letters and diaries. At one time we find him complaining of the long formal dinners, and late sitting after them, at a country house;

and at another he criticises Brighton, and declares it "very commonplace and poor." "There are," he says, "in it no natural beauties to distinguish it from a thousand other places; there are no high interests concerned, to raise it above the poor distinction of being a place resorted to by company, because other company was there before them." Speaking of George IV.'s silly gimcrack, the Pavilion, he said that "there was scarcely a cottage about the poor village of Crab Niton that did not in beauty and use surpass it." "It had," he observed, "no beauty for the painter, and what is intended for beauty, of which there is a great deal, had no use."

As is common with many great men, Faraday preserved in his mature years a childlike simplicity of character and love of juvenile amusements. After dinner, when he was between twenty and thirty, he would play with his wife's younger brother at ball, or with horse-chesnuts, and ride round the theatre on a velocipede, then quite a new thing. He was also fond of going on the river in a friend's cutter, and meeting the leading artists and singers, Turner and Malibran amongst the number. In the same circle, he would take part in charades. Mr. George Barnard, who supplies these reminiscences, states that "storms at all times excited his attention, and he was never tired of looking into the heavens." Once he said to him, "I wonder you artists don't study the light and colour in the sky more, and try more for effect." It was this quality in Turner's paintings which made Faraday admire them so much.

Miss Reid, Mrs. Faraday's niece, contributes some very interesting information about this period, when she was only seven years old. Her uncle was then studying elocution under Smart, and gave her reading lessons, going over sentences with unwearied patience, and then amusing the child with a good romp. She was sometimes left with him in the laboratory, the condition being that she was to sit in a corner, and as still as a mouse. He would go on with his work, occasionally giving her a kind word, or throwing a bit of potassium into water to amuse her. She describes him as her unfailing comforter in all childish troubles, and recalls the vivid pleasure she experienced in passing a month with him at Walmer, when he watched sunrises and sunsets, gathered wild flowers, and taught her their scientific names, and brought in hermit crabs, anemonies, and sea curiosities from the beach. She says, "My uncle read aloud delightfully. Sometimes he gave us one of Shakespeare's plays or Scott's novels. But, of all things, I used to

like to hear him read "Childe Harold," and never shall I forget the way in which he read the description of the storm on Lake Leman. Coleridge's "Hymn to Mont Blanc" delighted him, and when his feelings were touched, as he read, tears started to his eyes. He hated prevarication, and liked things called by the plain names. He encouraged prompt decision in trifles, and when his work was done entered heartily into childish games. His niece remembers how fierce he looked when made up as a villain, and she also recollects him playing the part of the learned pig! He liked to go occasionally to the theatre or opera, but was never a frequent visitor, and when fully engaged in his scientific researches, he found little time for general reading; but a tale "with a thread in it," afforded him relaxation.

In 1835 Sir J. South told Faraday that Sir Robert Peel had stated his intention of conferring a pension upon him if he had remained in office. Faraday at first wrote a reply, declining any pay that was not for services performed while he was able to live by his labours; but, upon his father-in-law's advice, he did not send this letter, but another with a less decisive refusal. Soon after, when Lord Melbourne was in office, Faraday waited upon him at the Treasury (by his request, as we heard, though Dr. Bence Jones does not say so), when the Prime Minister offered a pension, but with the bad taste of stating that he thought pensions to scientific men "humbug." Faraday went home, and wrote to Lord Melbourne, declining the pension, as "he could not with satisfaction to himself accept at his lordship's hands that which, though it has the form of approbation, is of the character his lordship so pithily applied to it." We have heard the sequel of this story told more graphically than as it appears in Dr. Bence Jones's work.

Lord Melbourne, we believe, mentioned the discovery of "a fellow who would not take a pension" as a good joke, and was startled when Lady Mary Fox pointed out that insulting one of the most eminent philosophers of the age might get the Whigs into trouble.

The story reached the ears of the king, and "it pleased him to remind his minister of it whenever he had an opportunity." Negotiations with Faraday then began; but the philosopher was not to be appeased by "soft sawder," and would not take the pension without a written apology, and this Lord Melbourne had the good sense to write. His lordship doubtless meant no harm in the matter. He was not more ignorant of science than most other cabinet ministers. It had never been the policy of his party to

show any honour to intellect that did not tend to its own political advancement, and he deserves the credit of having honourably corrected a gross blunder as soon as he found it out. The contemptible behaviour of the Whigs in matters of science soon cropped out again, and Mr. Spring Rice (afterwards Lord Monteagle) wrote in 1837 to tell Faraday he was going to move for a Commission to inquire into pensions. His object was to ascertain what pensioners had valid claims to a continuance of the state allowance. Faraday replied to his letter "that if the grant did not retain the same feeling and character as that which Lord Melbourne attached to it, he should, with all respect for the government, have no wish for its continuance." Soon after came a circular from Mr. Spring Rice, asking for a list of his works and titles. The list was sent and the pension continued; but as Faraday's discoveries had before that time gained for him an immortal name, one should have thought that even a Whig politician would have had enough decency to abstain from anything which might look like doubting whether the great philosopher was worthy of his small reward. Contrasting with the miserable conduct shown in these matters by members of the ruling class, we must note with pleasure the straightforward kindness subsequently displayed by Prince Albert and the Queen. In 1858 Her Majesty assigned to his use a house at Hampton Court, putting it in proper repair and treating him with all respect and consideration.

In 1840 Faraday was elected an elder of the Sandemanian church, which office he held for three years and a half, preaching on alternate Sundays. His sermons are reported to have been very different from his lectures. They were delivered with great devotion, and composed as much as possible of Scripture phraseology. They were spoken from brief notes, carefully written on two sides of a card.

If we may judge from the style of letters written at different dates, Faraday's æsthetic tastes increased with his maturity. At the age of forty-nine, when travelling for his health, we find the following passage, written at Thun—"A storm came on, and the deep darkness of one part of the mountains, the bright sunshine of another part, the emerald lights of the distant forests and glades under the edge of the cloud, were magnificent. Then came on lightning and the Alp thunder, rolling beautifully: and, to finish all, a flash struck the church, which is a little way from us, and set it on fire."

His love of animals is exhibited in another passage, written at

Simmenthal, where he found "the frogs very beautiful, lively, bold, and intelligent, and not at all fearful. The butterflies, too, became," he says, "familiar friends with me as I sat under the trees on the river's bank. It is wonderful how much intelligence all these animals show when they are treated kindly and quietly; when, in fact, they are treated as having their right and part in creation, instead of being frightened, oppressed, and destroyed."

"The little churchyard (Oberhofen) was beautiful, and the simplicity of the little remembrance-posts set up upon the graves very pleasant. One, who had been too poor to put up an engraved brass plate, or even a painted board, had written with ink on paper the birth and death of the being whose remains were below, and this had been fastened to a board, and mounted on the top of a stick at the head of the grave, the paper being protected by a little ledge and roof. Such was the simple remembrance, but nature had added her pathos, for, under the shelter of the writing, a caterpillar had fastened itself, and passed into a death-like state of chrysalis, and, having ultimately assumed its final state, it had winged its way from the spot, and had left the corpse-like relics behind. How old and how beautiful is this figure of the resurrection!"

Faraday's endeavours to lead the public into a rational method of investigating table-turning, the question on which many ran mad in 1853, will be well remembered. Writing at this time to Schönbein, he exclaimed, "What a weak, credulous, incredulous, unbelieving, superstitious, bold, frightened, what a ridiculous world ours is, as far as concerns the mind of man. How full of inconsistencies, contradictions, and absurdities it is. I declare that, taking the average of many minds that have recently been before me (and apart from that spirit which God has placed in each), and accepting for a moment that average as a standard, I should prefer the obedience, affection, and instinct of a dog before it. Do not whisper this, however, to others." And yet, at this very period, owing to his peculiar determination not to mix philosophy with his religion, he was led to assign the follies he complained of not to bad education, or imperfect development, so much as to "The prevalence of unclean spirits working in the hearts of man," as "foretold of the latter days."

We have thus selected, from the two interesting volumes of Dr. Bence Jones, illustrations of Faraday as a Man, which, although brief, may seem to present a picture that is distinct and true. We find a singularly beautiful moral nature, an intense industry, a

great faculty of attention, and a remarkable steadiness to certain objects of thought. Of his mental subtilty we have not spoken, because we could not have exhibited this characteristic without an analysis of his scientific career. On some of his speculations on matter, as consisting of centres and lines of force, or of atoms, every one of which, while preserving its own centre, extended throughout the universe, we could have scarcely treated without extending this paper far beyond its length. In one passage, Faraday speaks of what he *saw* as making a much greater impression upon him than what he read of or heard described. Whatever was presented to him objectively by experiment or observation he realized intensely, and made it the foundation of speculations that guided future researches. It was not difficult for others to point out that his theories of matter were not complete. If right, as far as they went, they were obviously defective in the sense of completion; but, while others often tried to make their *un*knowing look like knowledge, he always preferred the aspect of a true and honest *gap*, when real knowledge failed, to any sham filling in with learned words. If his genius was not the most discursive, it was very clear, and was as honest as any that ever lived.

CORALS AND THEIR POLYPES.

(Concluded.)

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PART IV.

(With a Plate.)

THE varieties of the shapes of compound corals appear to be endless when their study is commenced, but as they become more familiar this impression is removed, and it becomes evident that there is a law respecting the production of diverse forms. The student learns to distinguish many species of the Madreporaria by their peculiar form, which is invariably the same; some may be ramose, frondiform, goblet-shaped, tuberose, or bush-shaped, but the general configuration is so constant that it is hardly necessary to examine the structures of the calice and of the hard parts, generally speaking, in order to be certain of the particular species. The variety of the forms of the Zoantharia, and the relation of particular shapes to certain definite structural peculiarites of the sclerenchyma are very interesting and instructive. There is no monotony amongst the many hundred

different groupings of structures. There are some most important questions respecting the correlation of growth and the idea of species, which can be partly solved by comparing the relations of the structures devoted to the nutrition and growth with those peculiar to the reproduction and multiplication of the individual polypes. Just as shrubs and trees are restricted to a certain definite shape according to the species, so are the compound forms of the corals, and it is very evident that budding, and the method of the growth of the bud, determine the general configuration in both. According to the position of the buds, their numbers and relative power of growth with respect to the parent stem, so is the future shape of the tree or of the coral; and in both instances the bud is a multiplication of the individual. The vegetable bud developes woody, cellular, and vascular tissues, and their combinations—stem and leaves, or their homologues, should the bud be a generative one. Every bud on a Zoantharian has the same power of developing the structural elements of the parent, and of bearing the particular nutritive and reproductive organs. The analogy of the vegetable bud and that of the Actinozoa is even closer than may be imagined after a cursory examination. In the majority of the gemmating stony corals the existence and growth of the bud depends upon the persistence of the nutrition and vital processes in the parent stem; but in some genera the bud soon becomes independent of the parent, and can live on and develope others when its progenitor has become a mere mass of unorganized carbonate of lime. Some monocotyledonous plants develope buds which are deciduous and there is a genus of Sclerodermic Zoantharia which has a species whose peculiarity is to produce buds from its external tissues as deciduous as those of the tiger lily.

Blastotrochus nutrix, Ed. and H., either retains its buds—several generations of which may encumber the outside of the wall—or drops them; and in the last instance they are of course independent of the parent and reproduce all its peculiarities. Something of the same kind of budding occurs to several of the Actinides and may be observed constantly in the aquarium. The sea-anemone expands its base, and after a few days a small bud developes upon it into a tiny tentaculate young form. Soon the base begins to contract close to the independent bud, which shortly loses all connection with the parent; nevertheless, the bud retains within itself some offshoots or portions of the mesenterico-ovarian membrane of the parent.

Some plants have rhizomes, and bud here and there upon them; the same arrangement occurs in the Zoantharia, and gemmation by

stolons is characteristic of a group of important genera, for instance, Astrangia, Cladangia, and Cylicia. When buds arise in numbers around stems in the vegetable kingdom there is a correlative growth of nutritive sclerenchyma and also of hard structure which preserves the integrity of the whole. The same occurs in the branching stony Madreporaria, and the correlative development of the supporting structure of the water systems varies in its method and form quite as much as it does in plants.

The supporting structures of the Actinozoa have been noticed in the former papers. It is the cœnenchyma and epitheca that most commonly bind together the parent stems and the growing buds.

Considering the enormous force of rushing water constantly acting on the outside of coral reefs, the effect of its direct pressure and the results of its withdrawing upon the fragile Actinozoa, the wonder is that cœnenchymal structures can be formed strong enough. Probably the human notion of strength would have urged the necessity of placing the densest, roundest, and most cœnenchymal species in the midst of the boiling surf, and the branching forms with a fine porose structure within the quiet of the lagoon under the lee. But it is not found in nature that such is the best or the readiest method of preserving the reef as a whole, or of determining the localities of species. Just as the palms and bamboos can withstand the constant pressure of tropical air-currents, and do not succumb to cyclones, so the slender-branched Madreporaria, and the cellular Milleporidæ and Porites receive safely the on-rush of giant waves, and flourish amidst the whirl of the surging sea. Within this zone are the massive forms, and in the quiet depths of the lagoon are the bulky Mæandrinæ, Diploriæ, and the spiny Mussæ, all being genera whose species are characterized by much cœnenchyma, or by an extraordinary thickness of wall. These are the oaks, the elms, and the chesnuts of the coral forest, and they are as incapable as those great trees of withstanding the elemental strife.

The nutritive powers of the corals that live in the surf are in constant activity; there is abundance of food there, a highly aërated sea water, and the amount of carbonate of lime and of other salts of lime held in solution with carbonic acid gas, and perhaps oxygen, is great; consequently the growth of the parent stem is rapid and the budding very constant. The cœnenchymal growth is very generally most lax, and yet, although it is porose in the extreme, its strength seems to increase with its lightness. This is remarkably the case with the well-known species *Madrepora abrotanoides*, Lamk. It grows to a great size, and, unlike many species, retains its

vitality deep down from the surface, and it throws out whorls of buds which soon become sufficiently developed into small stems to reproduce others. A transverse section of a small branch is a very beautiful object. The centre is occupied by the parent corallite, and its septa occupy the most central position. The characteristic large opposite septa, two in number, reach across the visceral space, and the smaller laminæ converge to their point of union. No decided wall surrounds this corallite, but only a mass of porose sclerenchyma with the openings pointing outwards. Buds radiate on all sides, and open at the circumference, and they are separated by small portions of hard tissue. Their septa will be noticed to be full of perforations and their walls to be equally porose. The denser structures on the outside are full of pores, and it is evident that instead of there being a film of soft membranous structure, covering a dense costal surface, as in the Aporosa, there is a soft tissue that passes deeply from the surface internally and communicates with the surrounding calices through the pores of the intercalicular cœnenchymal substance. The greater the number of the buds the greater will be the number of the points of attachment for the soft tissues in such genera as Madrepora. The appearance of the hard parts of a branch of *Madrepora abrotanoides* does not indicate strength, on the contrary, the mass looks extremely fragile. Yet the elements of great strength and of successful resistance to increasing pressure and traction are all present, and as a matter of fact the branches are excessively strong. The length of the lateral buds of *Madrepora abrotanoides* is of course restricted by the diameter of the branches, but that of the original and central parent corallite is extraordinary. There is always a central terminal calice which can be traced as a corallite down every branch to a corresponding corallite in the main stem. This coral grows in some reefs to a great size, and it will be observed that there is always a relation between the thickness of the lowest stems and that of the upper branches. Although the rapidly-growing upper branches may be some feet above the main stem, still this increases in its diameter as the others increase in height and thickness. There is evidently a curious power of compensation, and the superior budding is compensated for by a deposit of hard structure on the outside of the lower parts of the coral between the growing calicular margins. The budding is quite as slow in many genera as it is rapid in the Madrepora, and its rapidity has a very interesting relation to the position usually occupied by the species in the reef or on the quiet deep-sea bottom. Thus in *Lophohelia prolifera*, Pallas, sp., a species found

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CORALS.

in the quiet depths of from 80 to 300 fathoms, off the Norwegian coast in the North Sea, and in the North Atlantic, the corallum attains a great size. It is a bush-shaped mass, and its shape originates in the peculiar alternate budding upon the outside wall of the calices. There is no tissue like cœnenchyma connecting the buds, but the walls and septa are remarkably dense and strong. There are as many buds in a branch of *Madrepora abrotanoides*, three inches in length, as in the whole of the largest specimen of the Norwegian species. Now owing to the absence of cœnenchyma the development of the buds may be studied in Lophohelia, and I have carefully examined it.

One of the most interesting questions that presented itself at the outset of the investigation, was, whether the budding took place from the internal membranes, or from those covering the outside of the corallites—the external. Whether in fact there was any connection between the mesenteric and generative folds of the internal membranes and those of the bud, or whether the external membranes developed the reproductive organs of the new corallite. It is evident that in the gemmation of the Actinides (that is to say when it occurs in the manner mentioned above, from the soft base) there is a small portion of the tubular structure of the ovarian folds included in the small bud. But in order that this can occur in the stony corals, like Lophoheliæ, there must be some absorption of the hard wall of the corallite, and a protrusion of the internal membranes and their contact with the under surface of the external tissues. Such a perforation and contact are simulated in some corals, when the budding takes place, close to the margin of the calice. The bud elongates and the original corallite continues to grow, and its cœnenchyma surrounds and over-laps the origin of the bud. But really there never was any connection between the membranes of the visceral cavity and those of the bud, which arise from the soft tissues of the disc, where they are reflected over the margin of the calice. Moreover, the perforation is simulated in the Lophoheliæ themselves, for as the bud grows, the parent corallite increases in thickness, and when the structures have arrived at maturity, the dense wall encircles the early growth of the bud, and presents the appearance of a continuous cavity from within, outwards. If the corallites are carefully cut down longitudinally, no trace of a continuation of their cavities with those of the buds on the outside can be traced. Yet the base of the bud is only separated by an excessively thin sclerenchymatous partition from the internal cavity. In one specimen it appeared that the bud sprang from the mem-

brane, which was situated between the two laminæ, whose lateral junction formed the septum, but I could not detect any satisfactory evidence of a direct connection between the membranes of the inner parts of the corallite and the external buds. The gemmation must then be considered to take place on the outside of the wall of the corallites. The innermost of the soft membranes which cover the outside of the wall, is of course the originator of the bud, and the first thing noticed is a slight puckering of the soft textures. Then a small convex growth takes place, and a tiny set of tentacules, six in number protrudes. The puckering is due to a depression in the outer membranes and the swelling of those underneath, and it would appear that whilst the under tissues have to do with the development of the hard parts of the bud—its wall and septa—the outer produce the membranes of the visceral cavity, the ovario-mesenteric folds, the disc and the tentaculer processes. The water-system whose anatomy has been described in a former paper, is well developed in all budding stony corals, and its regulating office is remarkably shown in Lophohelia. There is an obvious relation between the frequency of the buds, the size of the parent corallites, the direction of the gemmation, and the general shape of the whole corallum, which is most striking; and this only can be brought about by means of the water-system which brings all parts of the corallum in mutual relation, and which determines the nutrition of the largest and smallest offshoots. As the buds arise and advance to maturity, others spring from them, and contemporaneous with this increase of polypes is the wonderful strengthening and thickening of the lower and main stems of the corallum; and this is brought about through the canals of the water-system. The relation between the number of polypes and the size of the main stem is a question of nutrition, and the canals carry all the more in them when the budding is rapid and perfect. Occasionally the buds coalesce in their upward growth, and it is not uncommon to find some amount of dense cœnenchyma joining them together in Lophohelia. When this occurs, buds often spring from the surface of the cœnenchyma, and then there cannot possibly be any connection between the root of the bud and the internal tissues of a corallite.

Some specimens of *Amphihelia oculata*, Lin. sp., prove how exact the balance is between the gemmation and the thickening and hardening of the supporting stem. The stem is even marked with the long shallow ridges of the water-system. In this coral the gemmation is remarkable for its alternation, and for occurring on opposite sides of the stem only; indeed, the coral is built up of successive buds, and there is no true stem, for calice after calice

originates a bud at its outer margin. In the specimen under description the lowest part of the stem is a fractured calice, whose direction is to the left hand and upwards where its opening is distinct. From the upper and right hand side of the very margin of the calice, arose a bud which grew upwards and to the right. From its left margin arose a bud which passed off upwards and to the left. A succession of these zig-zag growths determines the general shape of the so-called stem, and as buds arise from the margin of the calices, opposite to those which give origin to the stem-forming corallites, a very dislocated looking corallum results. There is no connection between the interior of the successive calices, and the buds arise from the outer membranes just at the calicular margin. This is a good example of the extra calicular marginal gemmation. It is extra calicular, for the septa of the parent corallite are intact and are not interfered with by the buds. The Lophohelian gemmation is essentially extra calicular, and occurs like that of Amphihelia between the outside of the septa and the base of the corallite, and it is called, in both genera, infra-marginal. These corals are aporose forms. In the porose or perforate genera, the connection between the inside of the parent corallite and the bud is by no means so limited as it is in the others, for the general porosity infers the passage of soft tissues through the minute perforations of all parts of the corallum, and the base of a bud is therefore in some direct relation with the internal membranes. Nevertheless the rule holds good in a general sense, and the buds are developed by the membranes outside the calice, and there is no prolongation of the internal generative apparatus into the bud.

The gemmation of the huge *Dendrophyllia ramea* resembles that of the Amphiheliæ in its alternate character, but the original calice is not preserved in its calicular condition; it becomes a central, more or less porose stem, and the buds spring off at right angles. There is a very interesting coral which was described by Lonsdale for Sir Charles Lyell's "Elements of Geology," and which was first published in the "Geological Journal" on Sir Charles's return from America. The species occurs in the Miocene of Virginia, is usually found on *Pecten Madisoni*, and is known as *Astræa Marylandica*, Conrad; *Astræa hirtolamellata*, Lonsdale. Milne Edwards, and Jules Haime classify it with the Astrangiæ, and its gemmation occurs in two positions. The first and the generic kind I shall mention presently, but the second takes place from the outside of the corallum between the calicular margin and the base. Sections prove that there is no connection between the base of the buds and the inside of the corallites, and that the young polypes become

very highly organized and developed before they attain any height. The costæ can be seen on the parent polype underlying the base of the bud. This is, therefore, a convincing proof that the outer membranes develope the bud, and that the original hard parts have nothing to do with it in this species.

The first kind of gemmation in the Astrangiæ is from the expanded bases of the larger corallites. Every corallite has a broad membraneous base outside its proper base, and upon it are developed the buds, so that a collection of corallites may exist united by lateral prolongations of the bases. There is no exotheca, but a simple expansion of the costulated wall, and the buds are developed from the continuation of the same soft tissues that produced those of the second kind. A genus, Cylicia very closely allied to the Astrangiæ is singularly like the Actinides in its gemmation, for its budding takes place from the soft parts of an expanded base, and the membranes between the bud and the base do not harden as in the Astrangiæ, but are destroyed as in the ordinary sea anemones.

The gemmation of *Cladocora cæspitosa* is very frequent, and as there is no cœnenchyma it can be studied as easily as that of Lophohelia. The external membranes originate the buds, and the septa are close to the base of the bud, being separated from it by a thin wall. There does not appear to be any symmetrical arrangement in the development of the successive buds of Astrangia and Cladocora as there is in Amphihelia and in Dendrophyllia, and gemmation occurs without any definite order in the first-named genera. This unsymmetrical gemmation is very well seen in the Mediterranean Cœnocyathi. In one species the parent stem is nearly cylindrical, long and tapering inferiorly. Gemmation occurs here and there on any part of the very considerable surface between the calicular margin and the base. The young offshoots are scattered or crowded, numerous or few, and they all project at first from the corallite and then turn upwards and run in a parallel direction to the main stem. Sometimes they are so crowded that there is very little space between them. There is no order amongst them, except that the longer the original corallite the more numerous are the buds. The buds arise from the external tissues and are not connected by any cœnenchyma. Their shape protects them from the feeble currents of the deep sea. The gemmation of the Solenastrææ is irregular and lateral, it occurs in the space between the calicular margin and the base, and the offshoots arise from the external membrane and grow in the same manner as those of Cœnocyathus. But there is a strengthening tissue secreted by the outermost of the external layers which is cellular, and here and

there very stout, and which encircles the buds and the parent stems forming an aggregate corallum. The genus is usually found on exposed situations in reefs. In some of the species with very long and slender corallites which bud irregularly, for instance, *Calamophyllia radiata*, there is an exotheca which arranges itself in bands that clasp neighbouring corallites together, and bind up the whole, giving it strength and resisting power.

In such genera as Heliastræa, there is a symmetry in the upward and lateral growth of the corallum, and the upper margin of the cœnenchyma reaches very high up towards the calicular margin. The buds must therefore arise either from the surface of the cœnenchyma or from the corallite wall above its level. As the buds grow, the uniting tissue grows also, and speedily surrounds the offshoot. When transverse sections are made of the whole corallum the larger corallites are seen to be separated by cœnenchyma in which are the small round outlines of the buds. The amount of the cœnenchyma varies, it is very little when the costal structures and the exothecal dissepiments are fully developed, and great when these are rudimentary. There appears to be a singular correlation of growth between the cœnenchymal structures, the exotheca and the costæ and the size of the wall and the entirety of the septa. As a rule any extraordinary growth outside the corallite wall is compensated for by a diminished development of the internal hard parts, and the contrary occurs. The notion that the buds force their way up through the cœnenchyma is of course untenable. Budding quite on the margin of the calice, but outside the septa, is seen in many aggregate corals, and when there is a little cœnenchyma between very close corallites whose thick walls compensate for it and the absence of costæ, this infra-marginal budding is very common. The buds may arise between the corallites and from the top of the cœnenchyma, as in the genus Plesiastræa. When the cœnenchyma does not exist, and there are no costæ and no traces of exotheca, the walls of the contiguous corallites often unite and become fused. Each corallite then becomes more or less polygonal in transverse outline, and a common wall separates its internal cavity from that of its neighbours. The corallites thus united grow upwards, and there is no room for gemmation from the outside, and it cannot take place infra-marginally. It occurs within the calices or from the edge of the wall. The budding within the calices of aggregate corals with fused walls, is not fatal to the parent corallite, for the original calice still grows with the development of the bud. The budding produces the peculiar spreading and breadth of the corallum. The genus Isastræa shows this kind

of gemmation. A slight irregularity of the septa near the edge of a calice is seen; then in other specimens a rudimentary wall may be distinguished, forming a boundary between the original wall and the columellary ends of the septa. Within this little space the bud was developed, and it must have arisen from the internal membranes of the corallite, and the visceral cavity of the parent must have opened into that of the bud. It would appear, however, that a calcareous division was soon established, and before the bud attained any considerable development it became independent. The position of the calicular bud is submarginal in this genus, but it may be independent of the margin and take place on the top of the septa.

The calicular gemmation of the aggregate corals is observed even in the Palæozoic genera, and it is particularly well seen in the simple or solitary forms of that age. The growth of buds from the calices of simple or solitary corals is very common in the Cyathophyllidæ, and *Cyathophyllum parricida* is a well-known example. It is not particular to Palæozoic genera, however, for it is witnessed in those of the Lias, and even in those of the recent fauna. There is a very singular method of growth in many solitary corals that simulates calicular gemmation. It occurs in species which have intervals of growth and quiescence. The endothecal dissepiments between the septa, and midway between the wall and the columellary space, arrange themselves into a false wall and rise up to the level of the upper margin of the septa. There is then the appearance of an outer and an inner wall, and the tentacules and all the soft tissues outside the inner wall abort and decay, the calicular cavity becomes limited in its area, and then the inner wall and the septa grow upwards. This may occur many times and it gives the appearance of a series of calicinal gemmations, but it is really nothing of the kind. The limitation of the calicinal area is due to defective nutrition. In *Caryophyllia cyathus* a bud may occasionally arise from the septa and grow finally as large as the parent corallite, but its development is fatal to the progenitor, and I believe it is an accidental gemmation produced by the retention of an ovum within the mesenteric folds. Mr. Kent, of the British Museum, is about to describe a simple coral, like a Flabellum, which has calicular gemmation, and the growth of the bud destroys the parent. In *Cyathophyllum parricida* several buds spring from the same calice at once, and the parent dies as they are developed. But in all the cases of calicinal gemmation the bud must arise from the internal membranes. There is no rule, therefore, concerning the limitation of the gemmules to any particular soft tissues.

The solitary stony corals propagate usually by ova, and probably this is the case with the compound forms. Usually the solitary species do not bud, but when they do, the gemmation is generally from the calice, it may be, however, from the extra calicular surface.

The compound corals have either a basal, a calicular, or an extra calicular gemmation, and the budding, when calicular, may be marginal, submarginal, or more or less central. When the gemmation is extra calicular it may be infra-marginal, or it may occur on any part of the outside of the wall.

The position of the gemmation is most useful in the classification of the sclerodermic Zoantheria, and when considered with the simplicity and aggregate condition of the corallum, and its serial, fissiparous or regular method of growth, constitues an important element of specific and generic diagnosis.

The anatomy of the tabulate division of the sclerodermic Zoantheria is still in a very unsatisfactory condition. The gemmation is from the outside of the parent corallites, and as yet I have not been able to detect any budding from within in such genera as Pocilopora. The amount of cœnenchyma between the corallites differs in many parts of the same corallum, and is worthless as a generic diagnostic. Yet the supposed persistency of the cœnenchymal structures has much to do with the classification. The difficulty of associating the hard parts of such a genus as Pocilopora with the recognized anatomy and physiology of the Hydrozoa is at present insuperable, and there is no field of research more open to young naturalists than that of the histology and classification of the so-called tabulate corals. Louis Agassiz reasserts his statements concerning the hydroid character of the polype of Millepora; but no generative organs have yet been noticed upon it. Until these have been distinguished, the matter must remain uncertain.

Equally important is the study of the wearing out of the Palæozoic types of the Rugosa, and their recognition in the Secondary, Tertiary, and recent coral faunas. In fact up to the present time the corals of the Carboniferous, Devonian, and Silurian formations, have been considered to be perfectly distinct from those of the secondary rocks. The Permian system of deposits is almost uncoralliferous, and the distinction between the old and newer types is thus made all the greater, but the lingering of the Palæozoic peculiarities can readily be noticed in the Triassic, and even in the lower Liassic faunas. I have described a Rugose coral from the Australian tertiaries, and one from the West Indian Miocene, and

there is a well-known Rugose genus in the lower greensand of England. Pourtales has discovered a form in the deep sea, off Florida reef, with Palæozoic peculiarities. These may be cases of Atavism, and probably they are. Nevertheless, it is evident to those who have seen large series of corals from all the known coralliferous Palæozoic, Secondary, and Tertiary strata in every part of the world, that the Pelæozoic forms were the progenitors of the Triassic, and that synthetic genera existed in the earlier strata.

Careful investigation traces a gradation of structure between apparently distinct genera, through widely wandering and varying species, and the reference of this to a genetic relationship, commends itself more and more to those who can see no break in the succession of coral types, and no evidences of the miracle of repeated creations of them.

DESCRIPTION OF THE PLATE.—FIG. 1. *Astrangia Marylandica* on *Pecten Madisoni*, showing the growth from a common expansion of a basal membrane. FIG. 2. The alternate and opposite method of the gemmation of *Amphihelia oculata*. FIG. 3. The submarginal gemmation of *Isastræa*. FIG. 4. The gemmation of *Oculina*. FIG. 5. Pseudo-calycinal gemmation in *Caryophyllia cyathus*. FIG. 6. Infra-calicular gemmation of *Cladocora stellaria*. FIG. 7. The gemmation of *Lophohelia prolifera*. FIG. 8. The gemmation of *Cœnocyathus anthrophyllites*. FIG. 9. Corallites of a compound corallum; the budding is between the larger ones.

THE MOHAMMEDAN HISTORY OF EGYPT.

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CHAPTER V.

THE CIRCASSIAN DYNASTY (*Continued*).

E'ÑÁSER FÚRREG's successor, and the third monarch of the Circassian dynasty was—

El Melik El A'dil Abu-l-Fadl, A.D. 1406—1412.

He was not, however, destined long to retain possession of the government, for his chief minister El Mahmúdí soon compelled him to abdicate, and eventually exiled him to Alexandria where he passed the remainder of his days.

4. El Moáïud El Mahmúdí, A.D. 1412—1421,

Then usurped the vacant throne. This prince had been originally a Memlouk of the celebrated Berkúk's, and like several of his predecessors had raised himself to power mainly through his great activity and energy. In the commencement of his reign he successfully waged three wars in Syria against the Tartars, in the first

of which he sullied his otherwise fair fame by a gross breach of faith. The governor of Damascus, perceiving the impossibility of coping with so large and experienced a force as that which the Egyptian sultan commanded, wisely determined to capitulate, and on El Mahmúdí's promise that there should be no bloodshed, he surrendered the city. The sultan, however, as soon as he found himself master of the situation, thinking his vanquished foe might prove troublesome to him, cruelly massacred him with half the garrison. After the three engagements recorded above, El Mahmúdí enjoyed an exceptionally peaceful reign, and his name is recorded as that of a king who studied the happiness and prosperity of his subjects. An important alteration in the coinage of the country took place during the reign of this sultan. The para was, up to this time, of a drachm weight of silver; but Mahmúdí, resolving to perpetuate his name, abolished its circulation, and established in its stead the moáïudí, after his own name, Moáïud. Three kings now followed in rapid succession.

5. El Meduffer Ahmed, A.D. 1421,

The infant son of Mahmúdí, was quickly deposed by

6. E' Záher Abú'l Futteh Tatr, A.D. 1421;

Who in his turn was succeeded by

7. E' Sáleh Mohammed, A.D. 1421—1422.

This king, like his two predecessors, was destined to hold but a very short tenure of office; for his extreme youth rendering him utterly incapable of controlling state affairs, he was speedily deposed by

8. El Melik El Ashraf Barsabái, A.D. 1422—1438.

This Memlouk worthily continued the prosperous reign of Mahmúdí. In power, virtue, and courage, he ranks second only to Berkúk among all the princes of this dynasty. His reign is famous for his celebrated attack against Cyprus. He took John III. prisoner, who became his vassal, and also enforced the regular payment of tribute. About seven years after this he took considerable part in certain dissensions which arose between the court of Savoy and the government of Cyprus, and the great tact and discretion which he displayed, went far to quell disturbances which must otherwise have assumed a dangerous aspect. He ruled for sixteen years, with great clemency, and died in the year 1438. His successor was his son,

9. El 'Aziz Yúsuf, A.D. 1438.

His reign was but of short duration, for he was in less than a year deposed by

10. E' Záher Gékmeh, A.D. 1438—1453,

Who enjoyed a peaceful reign, during which nothing of any moment occurred. He abdicated at the age of eighty in favour of his son,

11. El Mansúr Othman, A.D. 1453,

Who was overthrown by the intrigues of the Khalifeh, El Káïm, and was succeeded by an aged Memlouk.

12. El Ashraf I'nal, A.D. 1453—1461,

Who reigned peacefully for eight years. His successor was his son

13. El Moáïud Ahmed, A.D. 1461.

During this sultan's reign the crown of Cyprus was given to James, son of John III., on condition that he paid a yearly tribute to the Egyptian treasury. He was deposed by

14. E' Záher Khúskudm, A.D. 1461—1467.

This monarch reigned for seven years with equity and toleration, presenting a marked contrast to the cruelty and oppression exercised by his successor,

15. E' Záher Abú-Sa'íd Bolbai, A.D. 1467,

Who rendered himself so obnoxious to his subjects that they dethroned him after a short reign of a few months. His successor,—

16. E' Záher Tumr Boghá, A.D. 1467—1468,

Also shared the same fate, and made room for

17. El Ashraf Káït Bey, A.D. 1468—1496.

This monarch deserves special notice for his many and successful struggles with the Turks, whereby the conquest of Egypt by that people was warded off for a few years. The first part of his reign was unmarked by any serious disturbances, and hence he was enabled to turn his entire attention to the controlment of the affairs of his own kingdom. He was however awakened from the lethargy into which he seems to have fallen, by hearing of a victory gained by Mohammed II. over his friend and ally the king of Persia. The sultan fearing that the conqueror might be desirous of invading his own teritory, posted a considerable force on the frontier of Syria. The brilliant successes of the conqueror of Constantinople made him anxious and willing to abdicate, but his ministers, fearing the result of so momentous an action, prayed him to defend his rights, and at length yielding to their entreaties, he prepared for war. The untimely death of Mahommed, however, and the dissensions between Báyezíd II. and Zizim temporarily relieved him of these apprehensions. In a short time Zizim fell, and having retreated to the Egyptian court, he implicated Káït Bey in the quarrel. On the final overthrow of that prince, the sultan did not wait to be attacked by the more fortunate Báyezíd, but himself began aggressive measures; inter-

cepted a Turkish caravan of pilgrims, and an ambassador from India, who was on his way to Constantinople with presents, and shortly afterwards took Tarsus and Adaneh. Such vigorous measures naturally excited the anger of Báyezíd, but to a remonstrance sent by him, the only answer of Káït Bey was a successful attack on the Turkish general, 'Alá-ed-Dowleh, who at a subsequent period joined the Egyptian army with his forces. Meanwhile, by a clever stratagem, Tarsus and Adaneh were recovered from him, but his chief minister, El Ezbekí, to whom was entrusted the conduct of all future wars, being despatched against these towns, retook them, utterly routed a Turkish army sent to defeat him, and in addition, annexed Karamania. The Turks, however, although defeated, did not allow their efforts to relax, but another force was quickly equipped, despatched into Syria, and for a time considerable success attended the Turkish arms. El Ezbekí was therefore again ordered to give battle; a squadron conveying troops was dispersed, and Tarsus became once more the seat of war. The result was at first unfavourable to the Memlouks; their commander rallied them, however, and under cover of night they succeeded in surprising and totally defeating the Turkish forces. For a long time after this victory, negotiations were pending between the rival nations, and at length Káït Bey, who was always peacefully inclined, ceded the disputed towns of Tarsus and Adaneh. By this means he secured peace for the rest of his life, being no more harassed by the attacks of the Turks. He died in the year 1496, having controlled the destinies of Egypt for twenty-eight years. During his reign the fall of Grenada gave a death blow to the Moslem power in Spain. He was succeeded by

18. E Náser Mahommed, Abú 'l Sadát, A.D. 1496,

Who, on account of the extreme barbarities he practised, was deposed by

19. Kánsúh, surnamed Khamsamíyeh, A.D. 1496.

This prince reigned eleven days; and then

20. E' Záher Abú-n-Nasr, A.D. 1496,

Usurped the throne, only to be deposed by

21. E Náser Mahommed (restored), A.D. 1496—1500.

His reign is marked by a continued succession of atrocities, and hence a great number of conspiracies were planned against his life. To one of them he fell a victim in the year 1500. His successor was

22. El Ashraf Ganbalát, A.D. 1500;

But being of a weak and vacillating disposition, six months sufficed

to accomplish his fall, and he was fortunate in escaping into exile with his life. The next sultan,

23. El Melik El'-A'dil Túmán Bey, A.D. 1500—1501,

Was acknowledged in Egypt and Syria. He was, however, overthrown and deposed in a few months. The Memlouks now compelled

24. El Ashraf Kansoóh el Ghóorí, A.D. 1501—1517,

To assume the dangerous dignity of sultan of Egypt. This prince very reluctantly yielded. His previous life shows him to have been both virtuous and learned, and he proved himself to be an able and just ruler. In the first part of his reign he was occupied in an expedition against the Portuguese in the east, which terminated unsuccessfully. No very serious results followed from this engagement, and he reigned in peace till the year 1510, when Kurkúd the father of Selím I., the Turkish sultan, obtained his protection and assistance. Events similar to those which accomplished the end of Zizim followed, and Selím, after the death of his father, availed himself of a pretext to declare war against Egypt. The first reverse which the Egyptians suffered, occurred to an army commanded by 'Alá-ed-Dowleh, formerly defeated by Káït Bey, but now in the pay of El Ghóorí. The latter now foresaw that a struggle was imminent, and the whole winter was passed by him in preparing energetically for it. In the spring he advanced in person. Selím, on his part, pretended to march towards Persia; but at the same time he sent to demand of El Ghóorí the reason why he opposed his passage, and peremptorily commanded him to appear before him on the frontier. El Ghóorí replied that his was merely an army of observation, and that he was desirous of mediating between Selím and Ismá'íl Sháh. The Turkish sultan, however, rapidly advanced, refused to listen to an attempt at negotiation, and was met by El Ghóorí on the plain of Marj-Dábik near Aleppo. A long and sanguinary battle ensued, and the victory for either side was doubtful until Kheyr Bey, commanding the right wing, and El-Ghazálí the left, of the Egyptian army, basely deserted to the enemy with their troops. The centre then gave way and fled in utter confusion, notwithstanding the strenuous efforts of the sultan to rally them. He was trampled to death by his routed cavalry, while (according to some) in the act of prayer. This event took place in the year 1517. With his death Egypt lost her independence.

25. El Ashraf Túmán Bey, A.D. 1517,

A nephew of the deceased king, was elected sultan by the shattered remains of the army which had collected in Cairo, and at once

determined on every resistance to the conqueror. His general, El Ganbardí, with as large a force as could be collected, disputed the road with Selím step by step, while the sultan himself awaited his arrival near Cairo. At the little village of Er-Reydániyeh, near the city, the opposing armies met. The Memlouks fought with desperate resolution, and for a time the issue of this renowned engagement seemed doubtful. At length the fall of a favourite general, Sinán Páshá, infuriated the Turks and incited them to more strenous exertions. The brilliant bravery displayed by the sultan's forces availed them not; they were soon utterly routed, and immense numbers of them slain in the pursuit. Túmán's general, El Ganbardí, no sooner perceived the disastrous result than he sacrificed his fame by joining the army of the victor. The Turks did not pursue the flying Memlouks long, but, wearied with the protracted battle, they paused to rest. This afforded the survivors time for re-uniting in Cairo, and the sultan, during the short respite, hired a large number of Arabs at a great cost to replenish his thinned ranks. Selím now moved forward with his forces to the west of Cairo. A night attack conducted by Túmán himself, though planned with a considerable amount of strategy, failed; but notwithstanding, the Egyptian army succeeded in putting to the sword a great many Turks. The final destruction of the fated race was, however, close at hand. The sultan retired into the city and endeavoured to fortify it, but his valour was of no avail against the superior numbers of the Turkish host. The temporary fortifications were razed, and a house-to-house combat ensued, the Memlouks defending every foot with the energy of despair. They were speedily overcome, and the luckless Túmán effected his escape towards Alexandria; but on the way he was taken by some Arabs, given up to his *quondam* general, El Ganbardí, and brought in chains to Selím, who at first received him with honour, but afterwards falsely accused him of conspiring against him, and with the cruelty and perfidy characteristic of his race, crucified him over the Báb-Zuweyleh, the place of execution for common malefactors. Thus miserably perished the last independent ruler of Egypt, a prince who possessed the best qualities of his line, and whose noble defence of his kingdom would have secured him the clemency of any but a Turk. Selím then completely abolished the monarchy, but left the aristocracy of the Memlouks under certain conditions, which were mainly, total subservience in all matters of faith to the Mufti of Constantinople, and the insertion of the name of the Turkish sultan in the public prayers and on the coin. The total

subversion of the power of the Memlouks, however, dates from the invasion of the French and the subsequent occupation of Egypt by the Turks, and the famed Mohammed Ali put the finishing stroke to their very existence.

In reviewing the period during which Egypt was governed by independent Muslim princes, consideration must be taken of the spirit of the times and the people over whom they ruled. They succeeded to the government of countries worn out by continuous wars, harassed by court intrigues, and overcome by savage hordes. The successive tyranny of the Persians, the Greeks, and the Romans, well-nigh annihilated Egypt's nationality, and when the Arabs invaded the country, this fact, combined with the religious strife constantly raging, induced the people to render the victors every assistance in their power. The troubles of the Khalífehs debarred Egypt from profiting by the enlightenment of the race who controlled her destinies until the conquest by the Fátimís. The princes of that dynasty contributed in a great degree to restore to Egypt some portion of its ancient prosperity, and with the Aiyubite family it attained its greatest military glory under the Muslims; but the edifices erected during the reign of the two dynasties of the Memlouk sovereigns, the libraries collected in the metropolis at that period, and the learned men who then flourished, also point to it as the age in which literature and the arts were cultivated with the most success; a certain sign of the internal prosperity of any country. This is the more surprising when we consider the state of Syria, which had long before their accession fallen a prey to intestine wars, as well as the ravages of the Tartars, Crusaders, and other invaders; and also bear in mind the constitution of their government in which the more powerful chiefs were constantly aiming at authority, augmented in their number by the Memlouks, who were chiefly Circassians, and afterwards composed the second dynasty—the Burgite. Many of the Memlouk sultans rivalled in military achievements, the great Saláh-ed-Dín, and even penetrated further than he in their foreign expeditions. In Cairo are preserved the finest specimens of Arab architecture, almost all dating from the period comprised under the domination of the two Memlouk dynasties; the libraries of the mosques and private collections of that city, though grievously injured since the Turkish conquest, are the best and most considerable of those of Egypt or Syria, and the university El Ashar is still, owing to the fostering care of these sultans, the principal seat of learning of the Eastern world.

REMARKS ON THE PROGRESS OF ASTRONOMY IN 1869.

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DURING the year which is now just numbered with the past, we have included, in our "Astronomical Notes" for each month, short notices of the progress of astronomical observation, so far as it has been employed upon objects in which the observers considered it desirable at once to make known the new information which they had been able to obtain. It is of course to be understood that great and important results can, generally speaking, only be arrived at by means of laborious and persevering courses of observation, continued through long intervals of time, and often necessitating careful comparison with other series of similar length. Results of this kind, by the nature of the case, only come before the world at epochs of some distance, and their attainment is usually developed by some great and far-reaching mind, which, after making a particular branch of research its special study, is enabled to grasp the bearings and significance of masses of fresh data, and thus claim new territory for the domain of ever-advancing science. But material is constantly being accumulated and stored up in this as well as in other sciences, which will doubtless, at some future period, become available for this great and noble purpose, and we can assure the reader that there has been no lack of activity on the part of astronomers during the year 1869.

Our intention here is merely briefly to recapitulate some few of the observations of special phenomena and objects to which attention has been given at any part of that year, most of which have been already mentioned in the pages of THE STUDENT. Their connection with the general progress of astronomical discovery will thus be more clearly seen, and enable us to look forward with better appreciation to the course of astronomical labour in the year which is just commencing. In this rapid survey it will perhaps be most convenient to treat in succession of the Sun and planets, devote a few words to the more erratic bodies which, under the names of comets and meteors, move within the limits of the solar system, and conclude with some remarks on the more distant sidereal systems and groups, respecting which astronomy has already taught us to know something, and the acquisition of more knowledge

is a principal object of the scrutiny in which modern instruments have placed it within our power to engage.

THE SUN.—We have more than once had occasion to refer to the extension of our knowledge of solar physics which has recently been achieved, principally by the use of the spectroscope. Those curious phenomena, known as red flames, or rose-coloured protuberances, which had been seen during a total solar eclipse on the circumference of the Sun's disc, either in actual contact with it, sometimes along a very considerable arc, or occasionally quite detached from it and separated by a short distance, were for a long time an enigma to astronomers. After the eclipse of 1860 had definitively decided that they were strictly solar phenomena, the interest felt in them was greatly increased, since it was perceived that their study might throw light upon the constitution of the Sun itself. On the occasion, then, of the great total eclipse of August, 1868, expeditions were fitted out by several European nations, and every effort was made by astronomers to avail themselves especially of the new means of observation and research of which they had become possessed, to acquire a complete solution of this interesting mystery. These endeavours were crowned with success, and the spectra given by the prominences (as they are now usually called) clearly showed that they consisted of great masses of gaseous matter, chiefly hydrogen, which were carried by upward currents to immense heights above the rest of the solar surface. M. Janssen, who observed the eclipse in Hindostan, conceived the idea of directing the spectroscope to the Sun's limb when there was no eclipse, and thus detecting the existence of the prominences and studying their contour at a time when they could be studied at leisure and free from hurry and excitement. This he succeeded in doing the very next morning after the eclipse, and thus satisfactorily established the fact that the principal constituent of those appearances was incandescent hydrogen gas, in enormous masses, and constantly undergoing movements of a most violent and tumultuous kind. Not long after this observation, and quite independently of it, our countryman, Mr. Lockyer, also succeeded in seeing the spectra of the prominences without an eclipse, and by the careful use of a new spectroscope, specially adapted to the purpose, was enabled to discover that the so-called protuberances, or prominences, were nothing more than local heapings-up of incandescent gas, which completely surrounded the Sun as an exterior envelope, to which he gave the name of the chromosphere. The continuous study of the prominent parts of this envelope, now that the possibility of doing so at

any time has been manifested, has not failed to be diligently taken up during the year 1869, and has thus made us more familiar with many circumstances concerning its nature and extent. In the July number of THE STUDENT (vol. iii., p. 441) we referred to Dr. Tietjen's observations of it at Berlin, and in the September number (vol. iv., p. 143) to those of Professor Zöllner at Leipzig. The latter especially are remarkable as showing the great height to which parts of the envelope extend themselves, and the great and rapid changes to which it is subjected, as well as the flickering flame-like motion which was seen by him on the occasion of the upward rush of great masses of the hydrogen, of which it appears to be principally composed. Professor Brayley has more than once in the Monthly Notices of the Royal Astronomical Society pointed out the probability that these prominences and the faculæ are in fact the same phenomenon seen, in the former case, outside, and, in the latter case, in front of, the Sun's disc. It has indeed been objected to this the faculæ are never seen excepting within a certain distance of the Sun's equator; but this may perhaps be accounted for by their position, when near his poles, interfering with their visibility.

Another phenomenon which is seen in central eclipses of the Sun has excited, and deservedly so, a considerable amount of interest—we refer to the so-called corona. Whether it is a solar, lunar, or terrestrial (atmospheric) appearance, has not yet been satisfactorily decided. It was thought that its light had been proved to be polarized, but Professor Pickering made some observations during the total eclipse of last August in America, which seem to show that even this cannot be considered as a definitively-established fact. The spectroscopic observations of the corona showed a continuous spectrum, both on that occasion and on that of the Indian total eclipse of 1868; but in 1869 bright lines were seen in it which had not been perceived the year before, and one at least, if not all three of these, coincided with those of the Aurora Borealis. Mr. Baxendell's suggestion* of the corona being due to a nebulous ring round the Sun (the existence of which he had shown by different considerations) reflecting the solar light, appears to call for further investigation. There is apparently no reason why this nebulous ring should not contain both luminous and non-luminous matter.

THE PLANETS.—Some interesting planetary observations have

* We called attention to this in the October number of THE STUDENT, vol. iv., p. 220.

been made during the year 1869. In particular, the knowledge which has been accumulated regarding the planet Mars, which, from its position and circumstances, offers more favourable conditions for accurate scrutiny and examination than any other, has been embodied by Mr. Browning in four stereograms, representing pretty closely the aspect of the whole of that body when best seen with really good telescopes. Mr. Proctor has carefully mapped out the surface of the planet, which, unlike our Earth, appears to contain a much larger proportion of land than water, and to be circumstanced, geologically or areologically, somewhat differently. He has also made a more accurate determination of the time of rotation of Mars than had previously been obtained, amounting to 24h. 37m. 22·735s.

Mr. Slack and Mr. Browning have both noticed a remarkable change of colour in the recent appearance of Jupiter's belts. We have been informed by Mr. Prince, of Uckfield, that this curious phenomenon, which certainly seems to suggest some "violent and peculiar action,"* has also been noticed by him.†

Only two small planets have been added to the list during the past year. Hecuba was discovered by Dr. Luther, at Bilk, on April 2, and No. 109, as yet unnamed, by Professor C. H. F. Peters, at Hamilton College, on October 9.

The Moon.—In mentioning the Moon, our nearest neighbour, we have not space to say much, but cannot omit to refer to Mr. Birt's zealous efforts to obtain an accurate knowledge of at least some particular regions on her surface. The detailed information he has been able to furnish of that interesting tract, the Mare Serenitatis, and is proceeding to complete of the remarkable object near her north point, known as Plato,‡ will give us, by comparing them with the appearances seen at some future time, a better hope than we have ever before had, of tracing, if possible, traces of present activity on the Moon's surface.

Comets.—We cannot say that much new physical knowledge has been arrived at concerning comets in the past year. One of the periodical comets has returned, according to prediction, and two new ones have been discovered, but all three are very faint bodies. The periodical one is that known as Winnecke's, which was dis-

* The Student for December, vol. iv., p. 379, where the facts above referred to about Mars are also given in a highly-interesting article.

† In a letter to the writer, dated November 18, he speaks of "a peculiar pink tint of Jupiter's equatoreal zones, especially between the two principal belts," and also states, that on one evening he "observed a very similar appearance near his north pole."

‡ We shall give Mr. Birt's drawing and description in our April Number.

covered by that able astronomer in the year 1858, and seen by him again (two periods having elapsed between, as the comet could not be observed at the return in 1863) on the 9th of April, 1869. It was afterwards observed by several astronomers, both before and after its perihelion passage, which took place on the 30th of June. The last person who saw it, so far as we are aware, was Herr Vogel, at Leipzig, on the 11th of October.

The two new comets were both discovered by Herr Tempel, at Marseilles, II. 1869 * on October 11, and III. 1869 on November 27†. Both have parabolic orbits: the former passed its perihelion on the 9th of October (two days before its discovery), at the distance of about 112 millions of miles from the Sun; the latter on the 21st of November (six days before its discovery), at the distance of 100 millions of miles.

METEORS.—We have but little to record under the interesting head of meteoric observation. The subject has continued to be well followed up, but not much has been added to our knowledge of the theory of meteoric rings, and their connection with comets. Vigorous watch has been maintained for the known systems, and particularly for the November shooting stars, of which a pretty considerable number was seen at some places, but falling far short of that of the previous year. It would appear, therefore, that the part of the ring passed through by us in 1869 was not an abundant one; nor, indeed, as we had before stated, did we expect that it would be. But it is a curious and remarkable circumstance that the shower, at this part of the ring, appears to consist of two or three distinct branches.

STARS AND NEBULÆ.—Stellar observation, as we have already remarked, has been in steady and vigorous action at many observatories, but, excepting some details respecting the visibility and magnitudes of some of the variable stars, establishing more completely than hitherto their periods and the nature of their changes

* Since the publication of the last number of THE STUDENT, we have learned that this body was observed by M. Stéphan, at Marseilles, on the mornings of the 1st, 2nd, and 8th of November; on the latter day its southern declination was very great. He stated ("Astronomische Nachrichten," No. 1781) that it was round, without tail, but having a point of condensation very apparent.

† Herr Vogel observed it at Leipzig on November 29, and found it faint, diffused, but round, and about 2½′ in diameter. Dr. Tiele observed it at Bonn on December 4, and found it "excessively faint, so that it was difficult even to discern it, and the observations were very uncertain." (Ast. Nach., No. 1783.) It was nearest the Earth on December 9, approaching us on that day, according to the calculations of Dr. Oppolzer of Vienna, within about 29 millions of miles.

of magnitude, and a few fresh discoveries in that direction, not much of a striking character has come to the surface in 1869. The most interesting investigations in this pre-eminently interesting department of astronomy, have been those of Mr. Proctor on the distribution of the nebulæ as compared with that of the stars, which tend to the conclusion that there is some closer connection than had been formerly supposed between these two classes of bodies, and that many of the nebulæ are no further distant from us than the stars. This remark probably does not apply to them all, and there is reason to believe that the spiral nebulæ in particular are bodies or collections of matter *sui generis*. Mr. Proctor's labours on this subject are worthy of the closest attention; they have been, however, so well set forth by himself in former numbers of THE STUDENT, under the title of "A New Theory of the Universe," that we may be excused from entering into them with any detail, though in a sketch, however imperfect, of the history of astronomy in 1869, it was out of the question to omit all mention of them. That gentleman also communicated to the December meeting of the Royal Astronomical Society an interesting paper on the conformation of the Milky Way, the result of which will probably command the assent of astronomers, but to which, in our present rapid survey, we must content ourselves with a bare reference.

PROGRESS OF INVENTION.

PRESERVING FOOD.—Preserved meats are much injured by the temperature to which they are necessarily exposed by the present method of preserving them. It is proposed to cause a partial vacuum in the vessel, in which the meat is kept, so that a less temperature will be sufficient for completing the operation. The cases containing the meat are attached by small pipes, having taps to them, to a suitable exhaust apparatus in order that a partial vacuum may be created. The method by which this vacuum is formed, is by the use of a pipe descending from a tank into a well of about thirty-two feet deep. The pipe is kept closed by a tap, when the tap is opened the water falls—and of course the air is sucked out of the tank—and the vessels containing the meat, which are in this tank, will be exhausted, and the cooking can proceed in the ordinary temperature of boiling water. When the operation is completed, the connection between the pipe from the exhaust apparatus is separated, and the aperture is sealed by soldering.

MANUFACTURE OF SULPHURIC ACID.—This substance is usually made in metal chambers by causing sulphurous acid evolved from pyrites or

sulphur, in connection with atmospheric air, to be oxidized by the agency of nitric oxide gas in the presence of steam. Mr. Louis Ash Israel, of the Minories, proposes to promote this union by causing fans or blades to revolve in the chambers. He also proposes to concentrate the weak acid formed by the use of super-heated steam. The acid is placed in a vessel, or chamber, which is heated by super-heated steam, the steam may come in contact with the acid, or not, as is thought most desirable.

PARQUET FLOORING.—Mr. George Needham Mansfield has patented a method of making inlaid flooring, which, from its simplicity and cheapness, has many advantages over other more elaborate and extensive processes now in use. He uses wood veneers for the wearing surface, and these he backs up with sheets or strips of kamptulicon, prepared either with or without an internal layer of canvas, or with the material ordinarily used for floor-cloths; or he uses india-rubber cloth, such as that manufactured for covering stairs, and which possesses the property of deadening sound. The veneer is attached to any of these backings by some adhesive material, and is so prepared as to resist the action of damp. An advantage secured by this invention is, that the covering may be laid down in strips or pieces of any form, and arranged in any pattern. It is attached to the floor by marine glue.

MANUFACTURE OF IRON AND STEEL.—Mr. E. H. C. Monckton's improvements consist in passing into melted pig-iron, placed in a suitable mould, or converter, superheated steam, until decarbonization is effected. In some cases, simultaneously with the injection of steam, in order to remove excess of silica and phosphorus, a mixture of charcoal with one or more nitrates, such as those of potash, soda, or lime, together with the addition of one or more chlorides, such as those of soda, potash, or lime, with or without a mixture of common carbonate of soda, etc., or of caustic, soda, etc., may be placed in the converting vessel with the melted metal. These operations may be performed in a reverberatory or puddling furnace if extra heat be required. Purified coal-gas may be used alone, or with superheated steam or air if desired. A great advantage proposed to be obtained by these methods is, that the iron may be worked in a mould of any desired shape.

MANUFACTURE OF GLASS.—A novelty in glass-making has been brought out by Albert Pütsch, Herman Pütsch, and George Leuffgen, of Berlin. It consists in using glass pots made of iron instead of fire-clay. The inside of the iron vessel is to be lined with fire-proof material, but it may, in some cases, be left partly or entirely without such lining. In some cases, the bottom or lower part only is made of iron, while the sides are of fire-proof material; but in all cases, no matter the shape of the vessel, it is necessary to keep the sides and bottom cool, either by atmospheric air or by artificial streams of air or water. The top of this vessel or tank is arched over, leaving the necessary openings for working,

and for the entrance and exit of the flame, which passes over the surface of the materials contained in the tank, and melts them. The fire-place may be of any suitable form and construction, and the tank supported in the ordinary manner.

Cocoa Biscuit.—In order to provide, in an edible form, cocoa with all its substantial and nutritive properties, a biscuit has been invented by Messrs. Richard and George Cadbury, of Birmingham. The ground cocoa is mixed with farinaceous matter, butter, and sugar, and is made into biscuits in the ordinary manner. It is stated that one object of the invention is to supply travellers and others, who are at times unable to take regular nourishment with some of the materials of their ordinary diet.

Ventilating Railway Carriages.—It is proposed by Mr. Alexander Cocke to place a grating round the roof lamps of railway carriages, for the escape of the foul air from the compartments; and this grating is to be surrounded with a shield, above which a cowl, capable of turning on a centre is placed, so that the outlet of the cowl may be in a direction contrary to that of the motion of the carriage. The lower part of the cowl overhangs the shield, so as to leave a space for air to play through it from below to its outlet. The centre of motion of the apparatus is obtained by a screw-pin passing into a socket in an open frame, capable of removal, over the lamp. This apparatus is also applicable to other apartments and places, and to chimneys, for creating a draught in them.

Cricket-balls.—A new kind of cricket-ball is made of compressed cork in the following manner:—The core is composed of this material; this is bound by twine or canvas, and the core is then covered with india-rubber until the desired size and shape are attained; it is then heated till it is sufficiently hard. But as the application of heat to the materials composing the ball would tend to injure the core between the binding and the core, and between the binding and the india-rubber, a coating of asbestos is placed; asbestos also being mixed with the india-rubber. By these means, when the ball is submitted to the action of heat, to *cure* the rubber, the core and the binding material are protected from the heat; and in this way a firmer ball is obtained than by any process hitherto employed.

LITERARY NOTICES.

Womankind in Western Europe: From the Earliest Times to the Seventeenth Century. By Thomas Wright, M.A., F.S.A., Hon. M.R.S.L., Corresponding Member of the Imperial Institute of France (Academie des Inscriptions and Belles Lettres). (Groombridge and Sons.)—As our readers must have anticipated, Mr. Wright's admirable papers on "Womankind in Western Europe," which have appeared in The Student,

are now published, with additional matter, and some more exquisite illustrations, in a single volume. Rarely has any author the satisfaction of seeing his labours presented to the public in such a splendid guise. This work, from its curious learning, elegant style, and superb illustration, will give valuable help to the historian, delight the antiquary, and charm the general reader. We have fortunately passed the stage in which history consisted of little more than a chronicle of regal quarrels and sanguinary conflicts. Students now want to know how the people lived, and how society grew, and no part of the investigation is more interesting, or more difficult, than to trace the position of woman, and her influence upon various times. The pictures presented to us by Mr. Wright open out new trains of thought, and are especially valuable when he comes to the periods just preceding the formation of modern society. His delineations of mediæval life are not calculated to make us indulge in romantic or sentimental lamentations over its departure, and whatever may have been the morality of the lower classes, the upper circles mingled with their refinement and luxury a coarseness and a licentiousness which lingered long, and very gradually passed away. Mr. Wright has handled this difficult topic with great skill. He tells enough for truth without offending delicacy. Of course his delineation of mediæval life is by no means complete. In this work he confines himself to one point, and it is all the more valuable from this fact, for it would have been impossible, within any reasonable limits of space, to have dealt with other elements in the social system of our ancestors in the same complete way. We need not say anything in praise of the superb coloured plates and innumerable woodcuts. Our readers know how to appreciate them, and we are confident they will welcome the work in its new form.*

THE TELESCOPE: a Familiar Sketch. Comprising a Special Notice of Objects coming within the range of a Small Telescope, with a detail of the most interesting discoveries which have been made, with the assistance of powerful Telescopes, concerning the Phenomena of the Heavenly Bodies. By the Hon. Mrs. Ward, illustrated by the author's original drawings.

THE MICROSCOPE: a Description of various objects of especial interest and variety, adapted for Microscopic Observation, with Directions for the arrangement of a Microscope, and the collection and mounting of objects. By the Hon. Mrs. Ward, author of the "Telescope." Illustrated by the author's original drawings. (Groombridge and Sons.)—The appearance of third editions of these well-known and admirable works, especially adapted to smooth the path of beginners, will be wel-

* If Mr. Wright had continued his subject to our own day, he might have added to his illustrations the curious fact, that the proprietors of large circulating libraries are afraid of works with first-class engravings, on account of the prevalence of a disease called *Kleptomania*, which causes beautiful prints, and especially coloured ones, to disappear. "Not on our list," often means "We are afraid of the disorder."

comed on all hands. Mrs. Ward—whose untimely death is so much to be deplored—happily joined the skill of the artist with real scientific knowledge, and a very pleasing style of writing. Messrs. Groombridge have wisely taken advantage of the popularity already won for these works, and issued the present editions at a lower price.

NOTES AND MEMORANDA.

Extracting Iron Projectiles from Wounds.—M. Milliot reports to the French Academy his success in extracting fragments of iron shells, or lead balls containing iron cores, from wounds, by means of electro-magnets. Using a portable horse-shoe instrument, with a conducting wire 109 metres long, and 1½ mm. thick, he attracted shell fragments at a distance of 15 mm.; with a straight electro-magnet, having 70 metres of wire, 2½ mm. thick, he attracted the same fragments at a distance of 40 mm.

Action of Electricity on Wine.—M. Scoutetten reports to the French Academy that a wine-grower at Digne had his house struck by lightning, which penetrated down to the cellar, and burst several casks of wine. The spilt wine flowed into a receptacle dug to receive leakings, and the proprietor, supposing it damaged, began to sell it at 10 centimes the litre; but in three months it was found so good that it sold for 60 centimes per litre. This led to experiments, from which it appears that sending a voltaic current through wine for a month or so, greatly improves its character. Some mediocre wines are stated to have been rendered excellent by this means.

Action of Compressed Air in Front of Projectiles.—Some papers on this subject have recently come before the French Academy, and on the occasion of M. Delaunay remarking on bolides and aerolites, General Morin observed that artillerists found that in firing over a level near the ground, the dust was raised right and left by the compressed air acted upon by the ball. Ancient cannoneers, he said, spoke of valleys as attracting balls, because in such situations the compressed air afforded the greatest obstacle to their passage. In firing along a horizontal wall, and near it, balls deviated, so that if the wall was at the right, the balls went to the left, and *vice versâ*.

Partial Explosion of a Bolide.—M. Silbermann observed a bolide about as big as Jupiter, traverse the Great Bear on 11th Nov., at 10h. 55m. (in Paris). Part of its course was straight, and part sinuous. It swelled out to three times the size of Venus, noticeably diminished its velocity, and threw out sparks in all directions. At first this bolide was bluish white: after the partial explosion, it was not bigger, and scarcely so bright as Mars, and its velocity was more than tripled.

Large Trees in Australia.—A Karri Eucalyptus, *E. colossea*, was found to measure 420 feet high, with proportional width, and a Eucalyptus, near Healesville, measured by McKlein, was found to reach 480 feet. "The Victorian trees," as remarked by Mr. Mossman ("Origin of the Seacoast"), "rival in length, though not in thickness, even the renowned forest giants of California." The highest, *Sequoia Wellingtonia*, is said to be about 450 feet.

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